Instruments

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TAG

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Instruments THE MAGAZINE OF Measurement and Control

M. F. BEHAR, Editor

Matching Jobs and Men

THOUGH our subscribers are all employed, we still get a few "better-job-wanted" calls and try to match these with "better-man-wanted" calls—but only in ways that help the War Effort. For the sake of interested readers (of both kinds) here are recent official and semi-official announcements:

1. Press Release, War Manpower Commission, July 6:

"Paul V. McNutt, Chairman of the War Manpower Commission, today made public a list of 138 occupations essential to war production in which there is a national shortage of labor.

"The list was compiled by the United States Employment Service in accordance with a Manpower Commission directive. It is based on the hiring schedules of approximately 11,000 major war industry establishments through August 1942, in relation to the current reserve of workers.

"The most serious labor shortages, Mr. McNutt said, are in the vital metalworking and industrial machinery trades, and in occupations essential to shipbuilding, aircraft, tool and ordnance manufacture. As examples, he said that for every available ship and boatbuilding assembler, 94 are needed, and for every available tool-maker, 31 are needed. . .

The list of 138 critical shortage occupations released on July 6 includes the following: Airplane inspector, Dynamometer tester, motor, Electrical tester, power equipment, Electrical tester, radio, Inspector (machine shop), Inspector (optical goods), Inspector, chief, casting, Instrument maker, electrical, Instrument maker, mechanical, Instrument maker, optical, Lens grinder, Lens polisher, Precision-lens grinder.

2. Abstract of article, "Fitting Workers to War Jobs," by Marjorie Van De Water in *Science News Letter*, July 11:

War has taken men from filling cream puffs in a bakery and put them to work filling shells in a munitions plant. Such change-overs will be made in minimum time and without wasting precious human resources, because of careful plans already laid before Pearl Harbor by job experts of the U. S. Employment Service. Their program of research on jobs, begun in 1933 and originally aimed at the war against unemployment, was ready to go into immediate action. Study of war jobs and peace jobs has revealed which are so closely related in terms of the human traits required that they can be grouped together in the same "job family."

A complete survey of available American manpower is being obtained through the Selective Service system. Forty million men, from high-school age to 65, have checked, on a list of 189 jobs, those for which they have training or experience. But the 189 job names include some 650 different occupations. The man who checks "airplane mechanic" may have worked at any of eight different jobs. Some job names cover as many as 20 different occupations.

To fill an essential job the first step of the government experts is to search its "family tree" to see what related job in a non-essential peace industry employing large numbers of workers is the closest "cousin." Often the non-essential "cousin" is so closely related that little training is required.

Here is how the job experts, under the direction of Dr. C. L. Shartle, trace occupational families.

First step was the setting up of a dictionary of "work done" verbs best describing the principal job of each occupation. Joining, heating, mixing, machining, measuring, spraying, designing—these are a few of the hundreds. Each of these is broken down into more specific tasks. Joining, for example, includes nailing, gluing, winding, welding, sewing.

Second step is to sort the related occupations according to the kind of machine or tools used.

Third step is to find out the degree of accuracy required.

Fourth step is to ascertain what is required of the worker. Does he have to possess muscular strength, dexterity, unusual eyesight, eye-hand coördination, or ability to follow complex written directions?

Fifth step deals with the kinds of materials used in the work. To sew canvas is not the same as to sew silk; and the surgeon who sews up wounds has an altogether different job.

When all this sorting has been done for the war job and for all related occupations, the job expert prepares the job family tree in a series of tables.

The first table includes all the jobs that are practically twin brothers to the war job to be filled. Little or no training would be required.

Then, as we go down the family tree, succeeding tables include jobs differing from the key job at first only perhaps in a single characteristic, later in more and more. But all are like the key job in some way or in several ways.

Example:—Demand for *gage inspectors* far exceeds the supply. Yet to become efficient in all the phases of this job would require years of experience and training—years during which the war must be won. To short-cut the training of raw recruits, the experts worked out a family tree for "gage inspector" including only peacetime occupations.

First branch (most closely related occupations) comprises jobs which involve precise measurements of materials, parts or assemblies, with the use of micrometers, calipers or gages and the reading of blue-prints. Four peacetime industries contribute: (1) stove manufacturing has a job called "atomizer specialist"; (2) radio has a "check inspector"; (3) automobile factories employ thickness inspectors and gagers; (4) the electric equipment industry has finishing inspectors, shaft inspectors, micrometer inspectors, circulating-process inspectors and raw material inspectors. Stoves, console radios, automobiles and waffle irons are out for the duration. These workers are first line of supply.

Second branch comprises jobs which involve setting up or operating a precision machine for shaping metal products. The clock and watch industry has fox-lathe operators, underturners, and wheel cutters.

In a third branch of the family are the workers who test machines or mechanical assemblies for satisfactory performance. Two additional industries may be tapped for this group: (1) office machines; (2) refrigerators.

CONCLUSION—We consider it our duty (1) to help transfer men from peace to war jobs and never the other way; (2) to explain to all concerned that "instrument man" covers many grades from "chart boy" to "Engineer."—MFB.

Existing Instrument Societies

Chicago—Chicago Society for Measurement and Control. Secretary: Carl Hope, 2626 W. 31st Blvd.

Newark—Society for Measurement and Control (New Jersey). Secretary: R. F. Robey, 409 Orange Ave, Cranford, N. J.

Pittsburgh—American Society for Measurement and Control. Secretary: L. M. Susany, c/o Carnegie Institute, 4400 Forbes St.

Instrument Society Organizers

Atlanta—M. V. Davis, Instrument Engr., Atlanta Steel Co., P. O. Box 1714. Also R. P. Saunders, 101 Marietta St.

Baltimore—C. A. Baker, c/o DuPont Co., Curtis Bay.

Hartford—G. L. Manke, Veeder-Root, Inc.

Minneapolis—Prof. R. E. Summers, Univ. of Minnesota.

Philadelphia—H. Jay Boyce, R. D. No. 2, Media, Pa.

Readers in these localities who desire to join should get in touch with these organizers.

Ordnance Production Gaging

By CAPTAIN RUSH A. BOWMAN

In charge of Pittsburgh Gage Laboratory, Ordnance Department, U.S. Army

CHAPTER II

INSIDE DIMENSIONS

Gagings may be divided functionally into the following classifications:

1. *Inside dimensions*, such as the inside diameter of a shell forging, the inside diameter of a gun barrel, or the inside diameter of a bearing as was discussed in Chapter I.
2. *Outside dimensions*, such as the outside diameter of the bourrelet of a finished shell, the pitch diameter of a

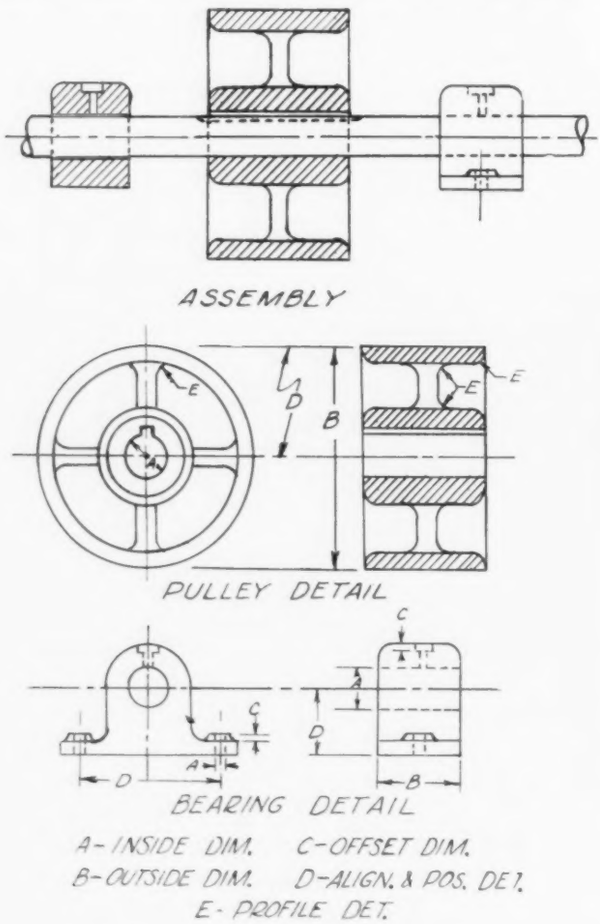

Fig. 1. Showing the Five Classifications of Gagings.

male thread, or the outside diameter of the shaft in the shaft-and-bearing case discussed in Chapter I.

3. *Offset dimensions.* These cover such determinations as the depth of counterbores, the heights of hubs on flanges, the depths of slots, the lengths of tapers, etc.

4. *Alignment and position dimensions.* Gages for determinations falling in this classification will be of many different types, but their general purpose will be the determination of relative positions of center points and center lines and the alignment of center lines. Some ordinary applications would be the concentricity of the inside and outside surfaces of a shell, the concentricity of a counterbore with its screw thread, the positioning of bearings in a gear fixture, the alignment of shaft bearings over an axle.

5. *Profile determinations.* In general, these will be the determinations of the conformity of the surface in general with the drawings or specifications. Some typical applications would be the ogive profile or the nose profile of a shell, the tapers of a cartridge case, or angles, rounds, fillets, chamfers, etc.

The drawing, Fig. 1, is designed to visualize this functional classification into five types of applications.

It will be found that any determination of size or relation to be determined by gaging will fall within these five classifications.

Our discussion of the gaging of inside dimensions and of all ensuing dimensions and determinations will be exclusive of material on thread measurement, which will be discussed in a later chapter.

The selection of gages must necessarily be based upon the types of service and the conditions and applications of the gage on the job.

Plug Gages.

The most generally used gages for inside determinations of all kinds are plug gages. See Figs. 2, 3, 4 and 5. A plug gage is a round cylindrical surface, usually ground and lapped and made to tolerances corresponding to the dimensions to which they will be applied according to Chart I.*

Fig. 2. Single-end Annular Type Plain Cylindrical Plug Gage with Pilot Feature.

Plug gages are most generally used in the inspection of comparatively smooth machine surfaces. They are not of course applicable where a throat condition exists (see Fig. 6) as in the measuring of the inside diameter of a shell after a nosing operation, or the offset to the rear of an inside thread.

Plug gages provide a rapid means of inspection of smooth finished surfaces. Plug gages are normally used in pairs, one made to a "go" and one made to a "not go" dimension as explained in Chapter I. Their most outstanding disadvantages are first, the fact that when worn beyond the tolerances and wear allowance of the gage they become useless, and secondly, they provide no means for determination of out-of-roundness with the "not go" element. An outstanding advantage of a plug gage, however, is the fact that it will—to some extent depending on its length—determine the straightness of a hole along with its determination of size.

Cylindrical plug gages are one of the oldest types of gages, having been in use for many years as standards for

*See May *Instruments*, page 174.

fractional dimension holes. Standard types of gages of this sort are now manufactured by most companies in the gage industry, although these are now entirely custom-made to purchaser's requirements. The following table shows commercial tolerances for this type of Standard:

RANGES AND TOLERANCES

SIZE RANGE Above	To & Inc.	Class XX Male gages only	Class X	Class Y	Class Z
0.029	0.825	.00002	.00004	.00007	.00010
0.825	1.510	.00003	.00006	.00009	.00012
1.510	2.510	.00004	.00008	.00012	.00016
2.510	4.510	.00005	.00010	.00015	.00020
4.510	6.510	.000065	.00013	.00019	.00025
6.510	9.010	.00008	.00016	.00024	.00032
9.010	12.010	.00010	.00020	.00030	.00040

Because of their wide application, general design has been standardized by the National Bureau of Standards and specifications have been set up for them under American Gage Design Standards, usually known as A.G.D. Specifications, published as Commercial Standard C S 8-41: Gage Blanks.

American Gage Design Standards set up specifications for construction of the plugs themselves by size, broken down into taper lock, trilock, and annular types, normal lengths of plugs and ordinary specifications for handles.

Plug gages are divided into three classifications as illustrated in Figs. 2 to 5, namely, single-end, double-end, and progressive. (This is, of course, in addition to classifications as set forth in Chapter I; namely, manufacturing gages and inspection gages.) The determination as to whether a gage should be single-end or double-end is based in general upon the size of the plug and the corresponding ability to manipulate it efficiently. A progressive plug consists of a single plug with the "not go," or larger, element adjacent to and following the "go" portion of the plug. It provides for more rapid inspection inasmuch as a single pass will make a complete determination as to whether the inside dimension is within tolerance. Its principal disadvantage is the fact that a progressive plug cannot be used in a blind hole; that is, a hole such as one drilled only part way into a piece of steel where a diameter determination is necessary to the very bottom of the hole.

Fig. 3. Double-end Plain Cylindrical Plug Gage, Taperlock Type.

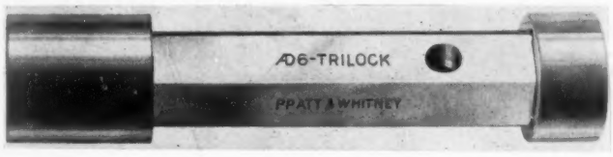

Fig. 4. Double-end Plain Cylindrical Plug Gage, Trilock Type.

Fig. 5. Progressive Type Plug Gage.

*Flat Plug Gages.**

Where it is necessary to measure the inside dimensions of flat surfaces a flat plug is normally used. Such a determination would be the width of a key way. A flat plug performs essentially the same duties as a round plug, but

*Frequently called "Square Plug."—EDITOR *Instruments.*

A Contribution to the War Effort

This unique serial is based on the remarkably successful course of lectures by Captain Bowman (then Lieutenant) to us Reserve Officers, in which he combined the fruits of his civilian experience as Gage Supervisor and of his Ordnance training.—MFB

it should be noted that in the event a quadrilateral hole is to be gaged, while a single "go" plug may be used to gage both dimensions, the "not go" determination of only one dimension may be made at one time. This constitutes a basic rule of gaging, that is,

while a "go" gage may be used to determine a number of relative dimensions, only one "not go" determination can be made at a time.

This is because, in the use of a "not go" gage, if the gage does not pass over or enter the part, as the case may be, the part is acceptable and any one dimension which is

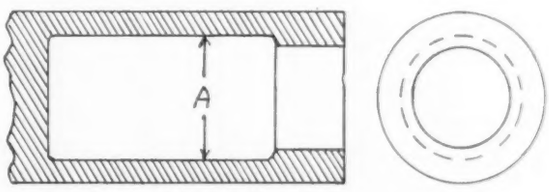

Fig. 6. Illustrating Throat Condition.

correct will prevent the passage or entrance of the gage and show the part to be acceptable, while other dimensions may be out of tolerance without being so detected.

Pin Gages

Pin gages are used generally in two far-removed applications. First, for an extremely rapid inspection of comparatively rough surfaces such as forged, die cast, rough machined parts, where tolerances of five thousandths of an inch or greater are experienced, such as the finished forged

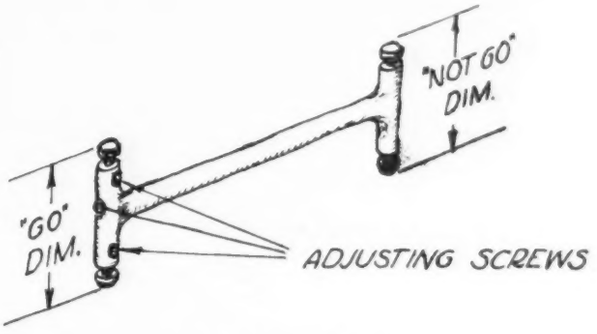

Fig. 7. Adjustable Pin Gage.

inside diameter of a shell. Secondly, pin gages are used for the finest measurements of feel on highly machined surfaces such as determinations on tolerances of one thousandth of an inch or less as in groove diameter of rifled barrels or bearing surfaces. Such a gage provides a sensitive method for "feeling" a diameter. See Fig. 7.

Some of the prime advantages of pin gages are their rapidity of use, their ability to measure inside diameters where throat conditions exist, and their ability to show up out-of-round conditions. Furthermore, pin gages are universally manufactured in the adjustable design in order that their life may be correspondingly increased. Because they are generally made as adjustable gages, they are normally less expensive although their original cost may be more than that of a plug gage of corresponding size.

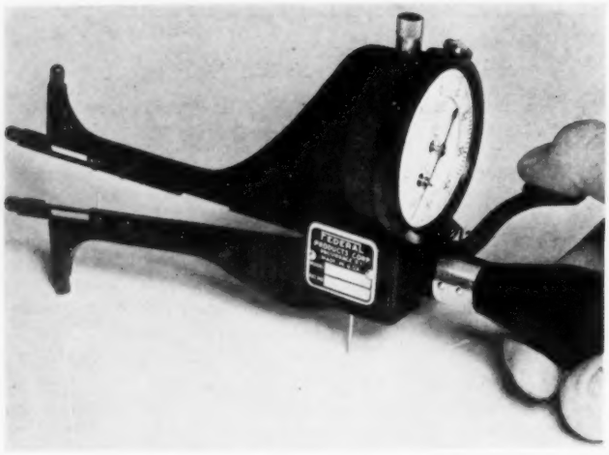

Fig. 8. Inside Caliper Gage, Indicating Type.

Fig. 9. Dial Bore Gage, Expanding Pin Type.
Note—Stem length on photograph before cutting off was exactly four times the length shown.

Special Types of Inside Dimensional Gages

Inasmuch as one of the most important fields in gaging is that of gaging inside dimensions, a considerable number of special types of gages have been developed for this purpose. Examples follow:

Indicating Inside Caliper Gages

Such gages are extremely useful in conditions where a small throat must be passed before the dimension to be gaged can be reached. See Fig. 8. Frequently a dimension may be gaged where the opening to admit the gage may be only 10 per cent of the diameter to be gaged. Principal disadvantage of such a gage is the fact that stability is difficult to maintain in the gaging points. This is due to two distinct inherent characteristics of this "folding" type: (1) the gaging points or arms do not constitute a true diameter since the blades are offset as the blades of a pair of scissors and (2) the blades themselves must necessarily swing in an arc from the fulcrum of the gage instead of extending radially.

Expanding Gages

Considerable development has been made in the line of *expanding pin gages*. Expanding pin gages are normally actuated by the movement of the pins on a taper bar, the position of which is measured at some point removed from the diameter to be gaged. See Fig. 9. One of the earliest forms of this type gage was the star gage used in the measurement of gun barrels. See Figs. 10 and 11. The star gage usually has a range of fifteen thousandths of an inch with the thousandths divisions about an eighth of an inch apart. Later types of expanding pin gages have been developed with an indicator for readings. The critical portion of such gages are of course the taper bars and likewise they are the most vulnerable parts inasmuch as the slightest deviation occuring in the taper bar will destroy the accuracy of the scale indications.

Somewhat similar is the *expanding plug gage*. See Fig. 12.

The latest development in the measurement of inside diameters is the air gage.

It may not be amiss to repeat our definition of a gage as given in Chapter I. A gage is a device for determining the *relative* size or shape of an object. It is not intended that a gage shall actually measure the physical dimension or shape but that it merely determine that the component is within the limits of tolerance. The special types of gages

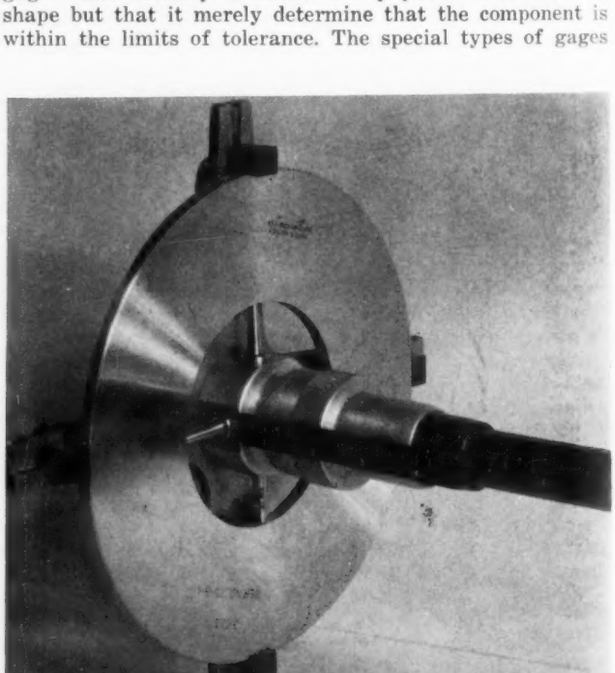

Fig. 10. Star Gage Being Set to Master.

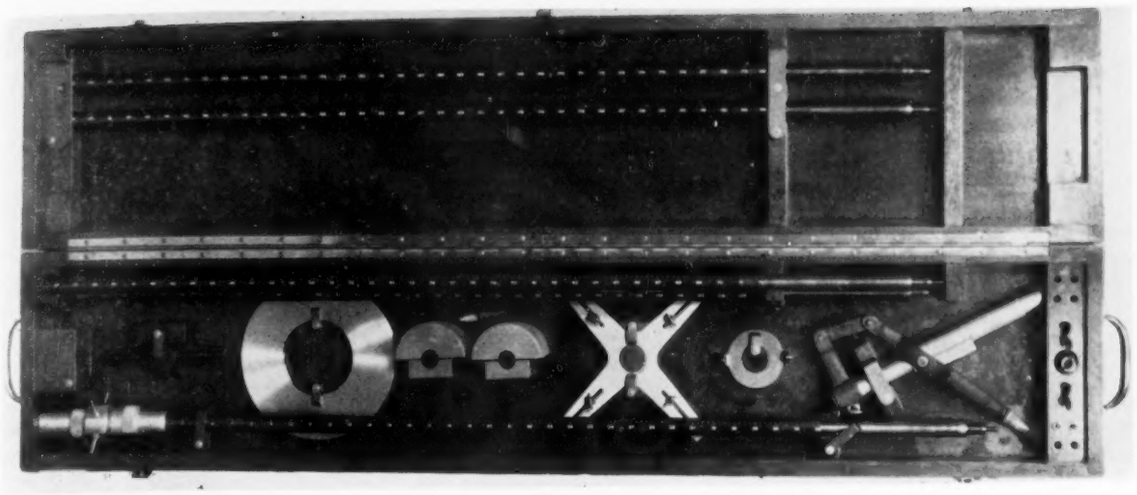

Fig. 11. Star Gage, Disassembled, in Case with Accessories.

Fig. 12. Gaging by means of an Indicating Type Expanding Plug Gage.

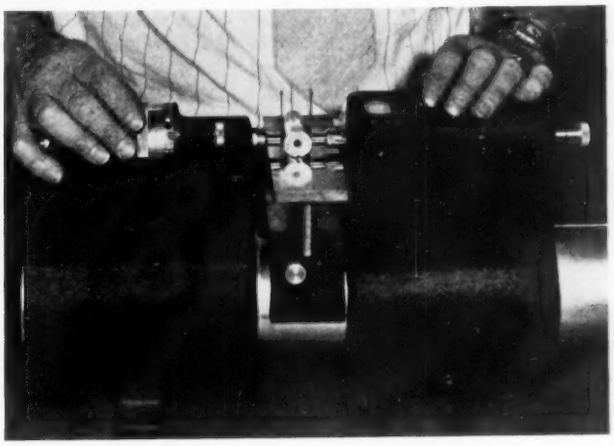

Fig. 13. Checking a Cylindrical Plug Gage by means of a Super-micrometer. (U. S. Army photograph)

as noted above are gages, although they have incorporated in them scales, dials, etc., which are usually associated with measuring instruments. It should be noted that it is necessary that a standard be provided in each of the above cases, such standards determining the limits of tolerance. Scales may be adjusted (by reference to standard rings, etc.) to correspond to the limits of tolerance but in general *only* the limits of tolerance are met.

Inspection

Plain Cylindrical Plug Gages

Plain cylindrical plugs must be measured with the following points in mind: The determination of the diameter, the roundness of the plug and the straightness of the surface. Outside caliper type gages or measuring instruments are used for these determinations. The accuracy will determine the instrument used. They are normally measured with an instrument having a controlled pressure if readings are to be taken accurate to one tenth of a thousandth. See Fig. 13. In order that the critical determinations as listed above be maintained, the gage should be measured at three or more places along its length, with measurements 90 degrees apart. When measurements are made the gage should be pushed between the anvils of the measuring instrument in a direction normal to the axis of the cylinder until the largest dimension is found, that is, the diameter. See. Fig. 14. Then the gage should be rocked in a direction parallel with the measuring points in order that the further determination of the true diameter can be made. See Fig. 15. The true diameter in such a movement will be found

(Continued on page 286)

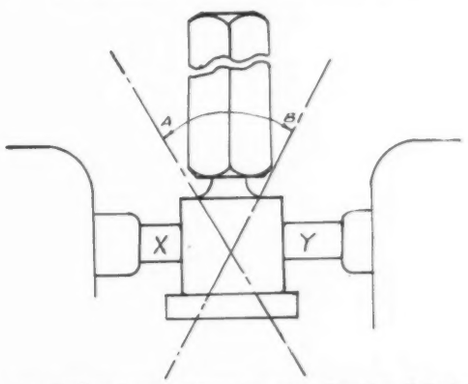

Fig. 14. Finding Largest Dimension when Checking Cylindrical Plug Gage—First Step.

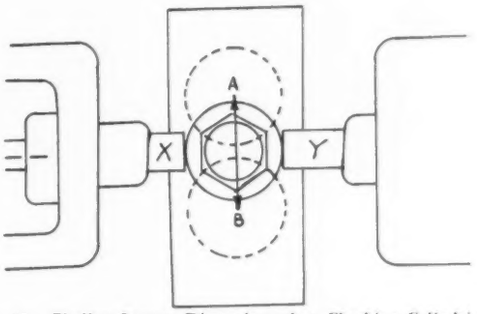

Fig. 15. Finding Largest Dimension when Checking Cylindrical Plug Gage—Second Step.

Maintenance and Servicing of Electrical Instruments

By JAMES SPENCER

Foreman, Instrument and Relay Testing, Westinghouse Elec. & Mfg. Co., Newark, N. J.

CHAPTER VIII

SYNCHROSCOPES

GENERAL PRINCIPLES*

In order to operate two alternating-current machines in parallel, there must be no difference in the voltages of the two machines; and both the frequency and phase position of the incoming machine must be brought to exact agreement with those of the system in order to prevent possible damage when the switch is closed. Among the various means used to verify these conditions before closing the switch, the synchroscope is an instrument which indicates by pointer rotation or oscillation the phase relation existing at any time between the voltages of the two machines to be paralleled.

The function of a synchroscope being to indicate phase relation, as is that of a power factor meter, some of the types of synchroscopes are similar to single-phase power factor meters and reactive factor meters in design and construction. (Therefore, much of the preceding chapter deserves study in connection with the servicing and repair of synchroscopes.) The essential difference between all synchroscopes and all power factor meters is that a power factor meter indicates the phase relation between current and voltage in one system, whereas a synchroscope indicates the phase relation between the bus or running-machine voltage and the incoming-machine voltage.

Only the pointer-indicating types of synchroscopes will be discussed in this chapter. All of these types may be divided into those which indicate by pointer rotation and those which indicate by pointer oscillation. The pointer-rotation types being the most numerous, a brief explanation will first be given of their general principles. Figs. 1 and 2 are simplified schematic sketches designed to show how such synchroscopes perform three distinct functions which may be described as follows:

(1) When the frequencies of the two machines are different, the pointer will rotate at a speed corresponding to the difference between the two frequencies.

(2) The direction of pointer rotation will indicate which of the two machines is the faster.

(3) When the frequencies have been equalized, the pointer will stand still, but its position will indicate the phase relation between the two voltages. As a rule, the vertical position indicates "synchronism" in the *complete* sense, that is to say, not only identical frequency but neither lead nor lag in the voltages.

In both Fig. 1 and Fig. 2 it will be seen that an arrangement of crossed-coils and phase-splitter (resistor-and-reactor) produces a rotating field.

In both Figs. 1 and 2 it will be seen that a third coil produces an alternating polarity in a soft-iron structure (an iron vane in Fig. 1, a field electromagnet in Fig. 2).

It is helpful to think of either the Fig. 1 or Fig. 2 synchroscope as a synchronous motor. Imagine for example that the terminals *B* in Fig. 1 are open and that the iron vane is a hard-steel permanent magnet. Then, if the *A* terminals are connected to a source of 60-cycle alternating current, the vane will rotate at 60 r.p.s. or 1200 r.p.m.—after being started, of course, because this rather crude form of motor is not self-starting. Likewise (though not *similarly*), if the *B* terminals in Fig. 2 are open and if we imagine the horseshoe magnet to be a permanent one, the revolutions per second the double-alternations per second crossed-coil rotor will rotate at a speed which will equal in of the machine to which it is connected.

Note, by the way, that in an ideal synchroscope it is immaterial which of the two elements (the crossed coils or the polarizing coil) is connected to the main system, and which to the auxiliary machine. The practical reason for the markings on instrument *terminals* is simply that the "fast" and "slow" markings on instrument *dials* are universally understood to refer to the incoming machine, the running machine or main power system being the reference standard.

Now let us drop the assumption of hard-steel permanent magnets but let us imagine that the third or magnetizing coil in either Fig. 1 or Fig. 2 is energized by a source of

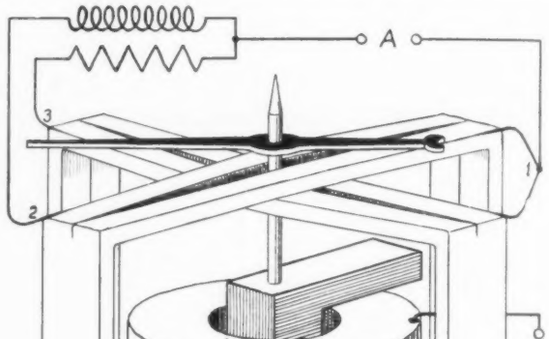

Fig. 1. Generalized sketch of a freely-rotating-pointer synchroscope in which the pointer is actuated by a polarized vane. Note the absence of springs.

(A) One of the crossed coils is in series with an inductance causing the current flowing through it to lag, by 90 electrical degrees, the current flowing through the other crossed coil. Therefore, the magnetic field in one coil attains maximum strength at the same instant of *time* that the field of the other dies down to zero. This occurs each quarter-cycle (90 electrical degrees). The coils are positioned at 90 degrees in *space*. During each complete cycle, therefore, the resultant field makes one complete rotation in space.

(B) During each cycle of the circuit to which the "B" terminals are connected, there is one instant of *time* when the upper end of the vane will have maximum North polarity; and another instant of time (180 electrical degrees later) when this same end will have maximum South polarity.

If A and B are in perfect synchronism, the two instants of maximum field strength of the coil which is in series with a pure resistance will coincide with the two instants of maximum field strength of the polarizing coil (energized by B). These two instants are also the two instants when the field strength of the other coil (in series with a pure inductance) is zero. Therefore, the vane will be influenced by the in-phase coil and not by the quadrature coil; and it will remain in the position shown in the drawing.

(This is not a drawing of any particular instrument but it roughly illustrates the arrangement of the Westinghouse "Type HA" Synchroscope.)

*This section has been inserted in Mr. Spencer's text by M. F. Behar, who assumes responsibility for assertions and recommendations.

direct current. The effect will be the same as before: "permanent" magnets, and the result will be the same: rotation of the rotating part (the Fig. 1 iron vane and the Fig. 2 crossed coils) at a speed in r.p.s. corresponding to the frequency of the a-c. source to which the crossed-coil and phase-splitter arrangement is connected.

Next, imagine that *either* the Fig. 1 or the Fig. 2 synchroscope has *both* its sets of terminals connected to *one*

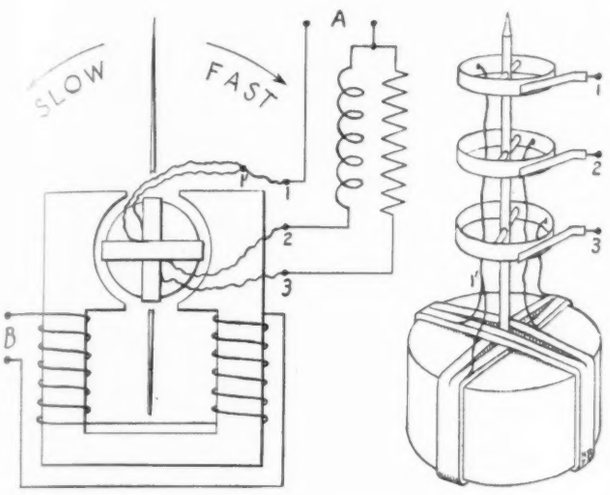

Fig. 2. Generalized sketch of a synchroscope in which the pointer is actuated by crossed coils rotating freely in an alternating field. This arrangement is, in most essentials, the reverse of the Fig. 1 scheme. The electromagnet produces an alternating field, so that if A and B are in perfect synchronism the coil in series with a resistance (3) will tend to place itself at right angle to the electromagnet's field.

(As with Fig. 1, this is not a drawing of any particular instrument but it roughly illustrates the arrangement the old Lincoln type made by the General Electric Co., many of which are still in service.)

alternator. Obviously, this produces perfect and complete synchronism. The rotating element stands still because the frequency of polarity reversals in the iron is identical with that of voltage alternations in the phase splitter and crossed coils. There being neither lead nor lag, the relative positions of the polarized and crossed-coil elements will be determined by the "purity" of the inductance and resistance in the phase-splitter. If this is ideal, the coil in series with the "pure" inductance will tend to position itself at exactly

A Contribution to the War Effort

IN normal times it is inadvisable for users of electrical instruments (except users such as utilities with full-equipped service laboratories) to do any work which involves opening up the case.

But this national emergency has created a shortage of electrical instruments, so that even plants enjoying priority have to wait. The top shelves of stockrooms are being searched for old instruments. "Irreparable" instruments are being "repaired." And —perhaps most important—all instruments in use must be maintained in good condition . . . by the users. Hence the crying need for this serial—the first and only one of its kind.

90 degrees in space to the magnetic field if the two elements are in phase opposition; and if in phase, the coil in series with the "pure" resistance will tend to take this position. In actual instruments, of course, these ideal conditions cannot be realized, but there will always be one *and only one* rotor position corresponding to perfect and complete synchronism, unless the instrument is out of order.

Next let us consider *either* the Fig. 1 or the Fig. 2 instrument connected to a running and to an incoming machine as in practice, the frequencies of the two machines being exactly matched but their voltages being out of phase by, say, ten electrical degrees. The rotating element will then assume a position almost exactly 10 degrees in space away from the position of complete synchronism referred to in the preceding paragraph. The exactitude of this phase measurement is not as important as it is in power factor meters: what is important is the zero position, because it is the basis of calibration and it will receive particular treatment in the detailed instructions which follow.

In the following, three representative synchroscopes will be dealt with: two types of polarized-vane or moving-iron instruments and one type of electrodynamic instrument. One essential difference between the two moving-iron types to be discussed is in their arrangements for producing rotating fields.

MOVING-IRON TYPE WITH REACTOR

Construction

The construction of a typical moving-iron type synchroscope is shown in Figs. 3 and 4. The construction of this particular type is similar to that of the single-phase moving-iron type power factor meter. The instrument consists of a

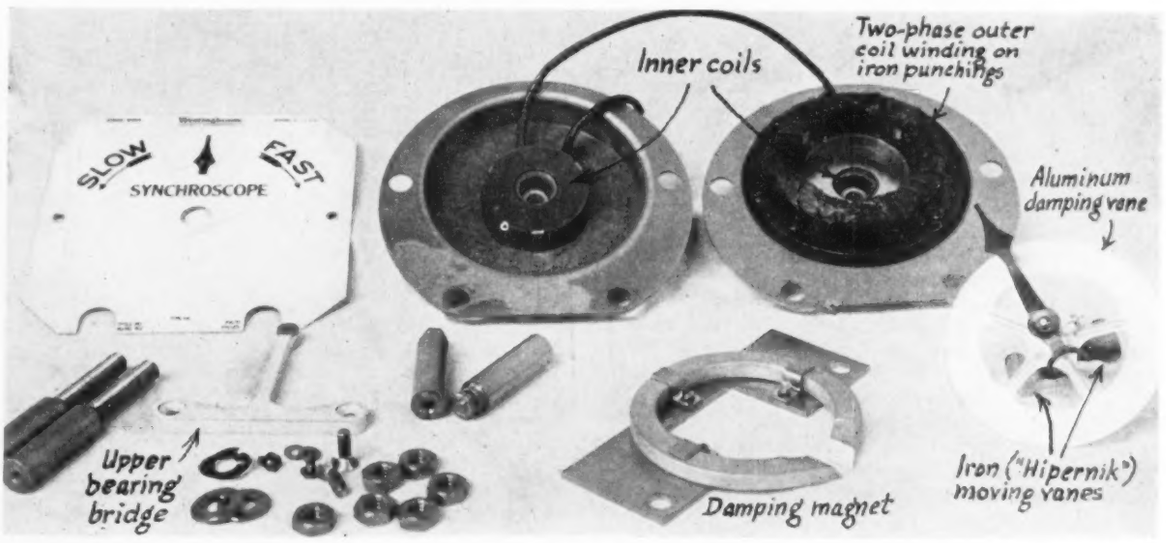

Fig. 3. The parts of a moving-iron synchroscope (without resistor and reactor). This instrument is the Westinghouse "Type HA."

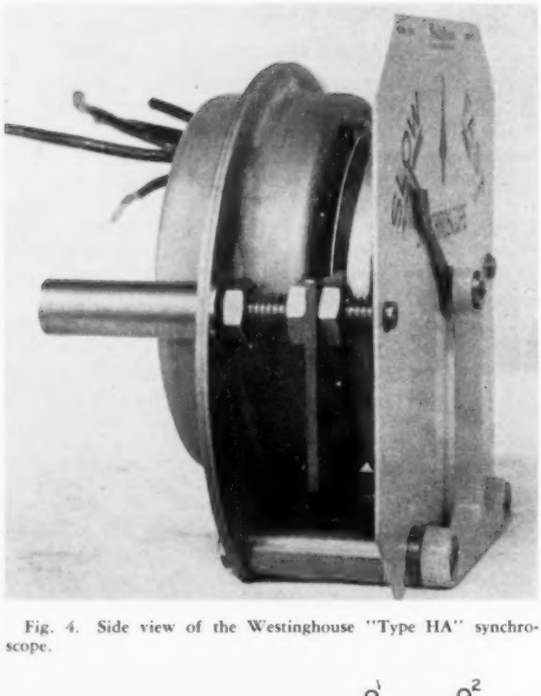

Fig. 4. Side view of the Westinghouse "Type HA" synchroscope.

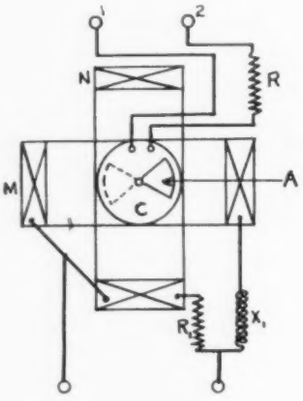

Fig. 5. Diagram of the connections of a moving-iron synchroscope.

M-N—External coils
C—Internal coil
A—Iron vane
R—Internal resistor
R_1—External resistor
X_1—External reactor

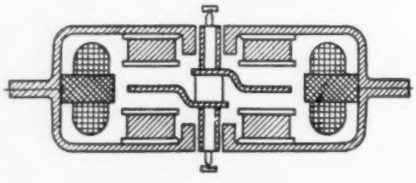

Fig. 6. Simplified diagram showing cross-section of Westinghouse moving-iron type synchroscope. Note that the field coils, the coil which polarizes the vane, and the vane itself, are not as shown schematically in Fig. 1. Compare also with the actual photograph, Fig. 3.

base frame and cover of iron or steel to mount and shield the movement and also to keep it dust-proof. The stationary element is made up of an internal coil in series with an internal resistor and two external windings as they are called. One external winding is in series with a resistor and the other is in series with a reactor as shown in Fig. 5. The moving element is a soft iron vane that operates in a channel between the internal and external coils. See Fig. 6. The vane is mounted on a shaft with hard steel pivots at both ends. The shaft rotates between two sapphire jewels. It also carries the pointer and an aluminum vane used for damping. The pointer is made tight on the shaft by a set screw through the hub to which the pointer is attached.

This instrument has no springs, the moving-iron element being capable of rotating freely.

The damping of this instrument is electromagnetic, using a permanent magnet and an aluminum disk.

The dial, which can be seen through the glass front of the cover, is marked with a dummy pointer for zero, an arrow in one direction marked "fast" and an arrow in the other direction marked "slow."

Principle of Operation

The principle of operation of this synchroscope is the same as that of a moving-iron single-phase power factor meter in that it has a split-phase circuit to the external coils, and an internal coil that magnetizes the movable iron vane. The damping arrangement is the same and the pointer rotation is dependent upon the same theory of operation. The internal coil is connected through a resistor across the terminals of the incoming machine; and the two external coils are connected split-phase through a resistor-reactor to the running machine as shown in Fig. 7. When the synchronous conditions as stated in the first paragraph of this chapter are met, the pointer will stop at a point marked zero with a dummy pointer and it is safe to throw the machines in parallel. Until the above conditions are satisfied the pointer will rotate either fast or slow as indicated on the dial.

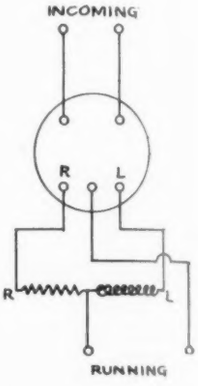

Fig. 7. Connection diagram for moving-iron type synchroscope.

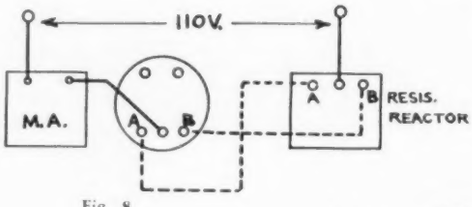

Fig. 8

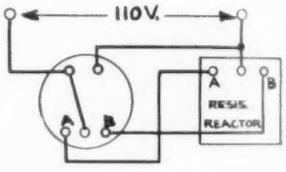

Fig. 9

Inspection and Calibration

The mechanical inspection consists of checking for friction, end play* and balance.* The damping disk should be true and be centered between the magnet and keeper. All visible parts should be free from scratches or other blemishes and all connections should be properly adjusted, well soldered and of good appearance. Screws and nuts should be tight and not burred or marred in any way. Lastly, the instrument should be well cleaned and polished.

Before the regular calibration test is given the instrument, a ground test of 1500 volts from coil terminals to ground and 1500 volts between internal and external coils is given.

After the tap or finish lead of the external reactor is connected, the instrument should be connected to a test circuit with a milliammeter as shown in Fig. 8. The tap lead is for 60-cycle application and the finish is for 25-cycle operation. The current in each side of the split-phase circuit is measured and equalized by changing the air gap of the reactor.

We next connect as shown in Fig. 9, apply rated voltage and set the pointer on zero. The pointer may be shifted by loosening the set screw in the pointer hub. After adjusting the pointer to its calibration point, be sure to retighten the set screw, to avoid pointer shifting when the instrument is in service. This is called the bucking point or point of synchronism by reason of the fact that both upper and lower

*End play adjustments and balance adjustments have been discussed at length in Chapter I.

circuits are connected to the same source and therefore subjected to equal circuit conditions. With the instrument in the normal position the pointer is balanced at zero and under the bridge at each side of the instrument, should the pointer move more than one inch from its setting, paint may be applied to the back of the damping disk as a means of balancing. In the more recent models of this type synchroscope, a threaded balance arm and a balance nut are provided for making balance adjustments. If balance is necessary, the bucking point must be rechecked and reset if found off.

The instrument and reactor-resistor is marked as shown in Fig. 9 to insure against wrong connections by the customer.

MOVING-IRON DUPLEX-ROTATING-FIELD TYPE

Construction

The synchroscope shown in Figs. 10 and 11 is also of the moving iron type. In this particular type of instrument, the stationary element is similar to that of a three-phase motor. This stationary element is mounted in a removable casing, attached to the back of the instrument by three screws accessible from the inside of the case.

Fig. 10. General Electric Co.'s "Type AR-4" synchroscope (instrument alone, without accessories). In this type the resultant of *two* rotating fields actuates a freely-rotating vane so that if the frequencies of the two sources are identical the vane stands still; and if the two sources are in synchronism the vane stands in one particular position.

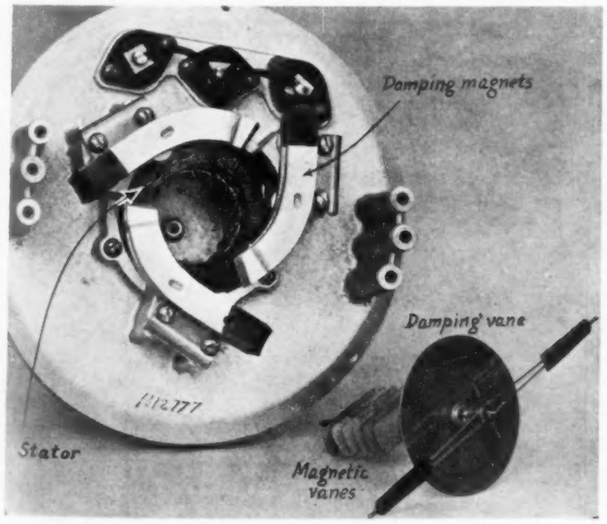

Fig. 11. Partly disassembled view of G-E "Type AR-4" synchroscope, showing rotating element withdrawn from remainder of mechanism.

The moving element, as shown in Fig. 11, consists of a shaft on which a double pointer is attached by a set screw, a series of iron vanes and an aluminum damping vane. The rounded pivots are mounted in threaded pivot holders that screw into the tapped ends of the shaft. This moving element operates between two cup-shaped jewels, one mounted in the lower end of the stator housing and the other in the bridge across the face of the dial.

The three damping magnets are mounted around the damping disk, so that their poles are 120 degrees apart. A small prick punch in each magnet fits over a pin in the

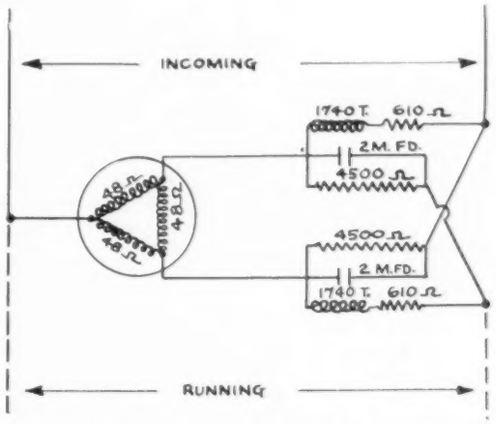

Fig. 12. Internal connections for G-E "AR-4" synchroscope and external impedor.

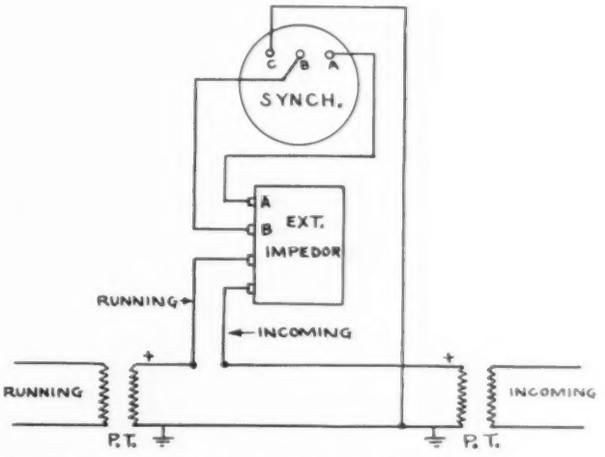

Fig. 13. External connections for G-E "AR-4" synchroscope.

mounting surface of the base to allow for pre-positioning of the magnets before clamping them in place. The dial is held in position by four dial screws, two on each side, just adjacent to the top bridge.

The impedance box is made with a partition in the center so that it has an upper and lower compartment. The four capacitors are mounted in the lower part, and the two reactors and resistors are mounted in the upper compartment. The reactors are bolted to the partition, and the resistor tubes are mounted on two studs attached to the center partition. The capacitors in the lower part of the box are held in position by wood blocks and a felt pad. External connections are made through four insulation-covered terminals through the side of the impedance box.

Principle of operation

The internal and external circuit connections are shown in Figs. 12, 13 and 14. The three-phase stator, with its double split-phase arrangement of resistors, reactors and capacitors, operates as a two-field mechanism, the fields

tending to rotate in opposite directions. The vanes of the moving element follow the resultant field of the two superimposed fields, rotating in a slow or fast direction according to the speed of the incoming machine. The instrument

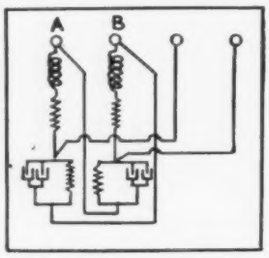

Fig. 14. Connections of external impedor of G-E "AR-4" synchroscope.

and impedance are so balanced that when the incoming and running machines are in synchronism, the pointer will stand in a vertical position at the zero or synchronous point on the dial.

Inspection and Calibration

If the instrument is suspected of being out of calibration, connect it as shown in Fig. 15 (bucking position). The pointer should stand vertical, pointing to zero. If a slight

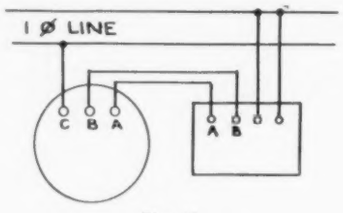

Fig. 15.

adjustment is necessary, the correction may be made by changing the value of the resistance in series with the reactor or across the capacitor.

If an accident has happened and it is suspected that the stator has been affected, the following test will prove helpful.

1. With the instrument connected as in Fig. 16, the pointer should indicate zero or synchronous position.

2. Remove lead *A*. The pointer should then indicate 60 degrees fast.

3. Reconnect *A* and remove lead *B*. The pointer should then indicate 60 degrees slow.

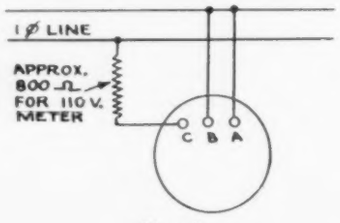

Fig. 16.

4. With *B* lead disconnected, change lead from terminal *C* to terminal *B*. The pointer should then indicate 180 degrees.

If the instrument reads as above, with the various connections shown in the figures, the stator is not damaged, and the element is in good mechanical balance.

End-play adjustments and balance adjustments have been discussed at length and need not be repeated here. The same applies to the care needed in making sure that clearances are correct, that all parts are clean and free from dust, etc.

ELECTRODYNAMIC TYPE

Construction

The synchroscope shown in Fig. 17 is of the air-damped electrodynamic type. In general, its construction is similar to that of the electrodynamic type voltmeter, except that the moving and stationary coils are not connected together. A diagram of connections showing both the internal and

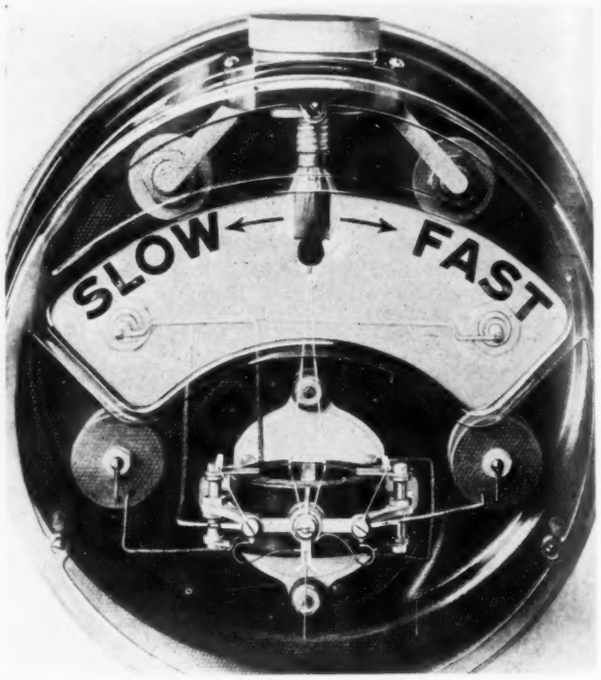

Fig. 17. Phantom view of Weston Electrical Instrument Corp.'s electrodynamic type synchroscope.

external wiring is given in Fig. 18. It will be noted that the circuit includes a special type transformer, having two primary windings and one secondary winding. The primary

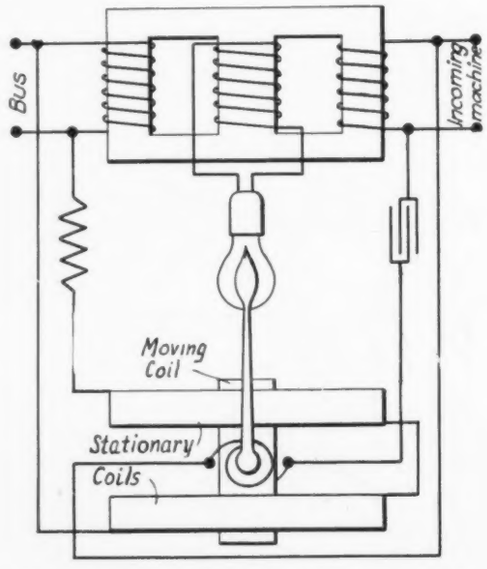

Fig. 18. Connection diagram for Weston synchroscope.

windings are connected to the machine being synchronized and the secondary winding supplies the energy for lighting the synchronizing lamp used in this instrument. Note that the pointer is *behind* the translucent scale, on which its shadow is cast by the lamp.

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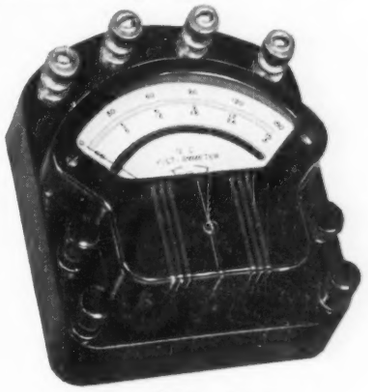

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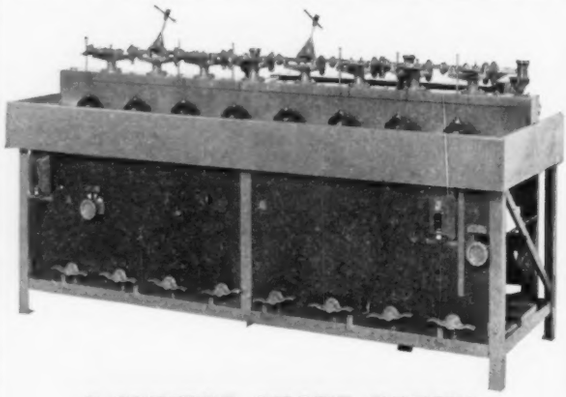

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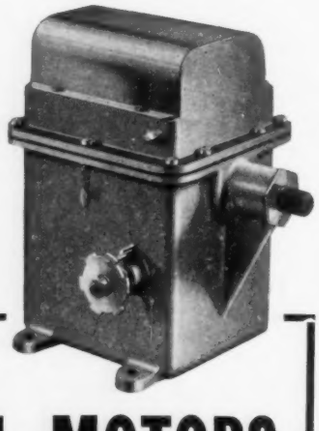

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Operating Principle

From the diagram, Fig. 18, it will be seen that a capacitor is connected in the moving-coil circuit, and a resistance is in series with the stationary coil circuit. The transformer, capacitor and resistor are mounted in an external box shown in Fig. 19 with cover removed. The circuit is so

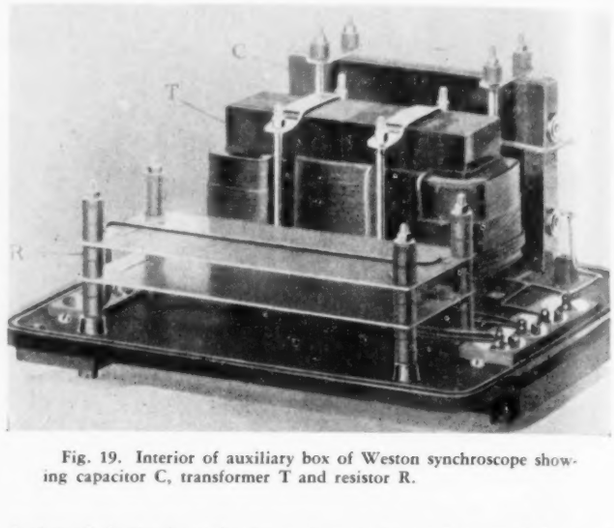

Fig. 19. Interior of auxiliary box of Weston synchroscope showing capacitor C, transformer T and resistor R.

designed that when the incoming and running machines are in synchronism, the currents in the moving and stationary coil circuits are out of phase by 90 degrees. When this condition occurs, no torque exists between the moving and

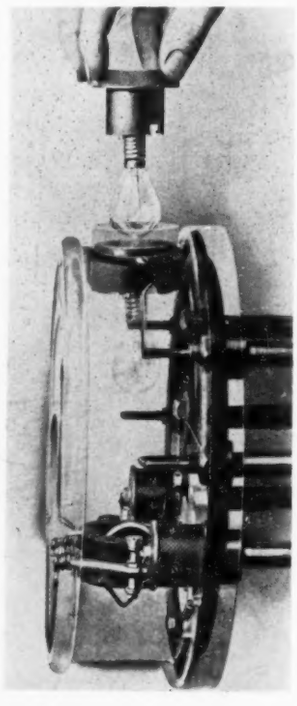

Fig. 20. Phantom side view of Weston synchroscope showing relative positions of lamp, pointer and translucent scale.

fixed coils, hence the pointer remains at the synchronous point just in front of the lamp. At this synchronous point, the voltages are in phase and the frequencies of the incoming and running machines are the same; therefore the secondary of the transformer receives its maximum induced voltage. At this maximum voltage, the lamp lights to its full brightness and the shadow of the pointer appears clearly on the translucent scale. Until the two machines are in synchronism, the pointer swings back and forth, and the lamp flickers, so that the pointer appears to be rotating. The lamp lights only when the two machines are *approach-*

ing synchronism, as when the machines are in opposition the resultant induced voltage is below the value required to light the lamp. When the incoming machine lags behind (runs at lower frequency than) the running machine, the lamp lights as the pointer swings toward the slow side. When the frequency of the incoming machine is higher than that of the running machine, the lamp lights as the pointer swings toward the fast side.

Inspection and Calibration

As with all synchroscopes, this type is calibrated by bucking the two circuits of the instrument and adjusting to bring the pointer on zero or the synchronous point. Bucking may be accomplished by connecting both sets of terminals of the instrument across the same line. The calibration adjustments of this instrument are: shifting the pointer, adjusting the resistance in the stationary coil circuit and balancing the element.

Possible causes of errors in this type of synchroscope would be similar to those found in other electrodynamic type instruments. The charts given in Chapters I and II should be helpful in tracing possible causes of errors if this instrument fails to operate properly.

The lamp circuit should be checked occasionally to be sure that the lamp is not burned out, as a dead lamp renders the synchroscope useless because no shadow of the pointer would be visible.

Should it be necessary at any time to remove the cover from the instrument, *first remove the lamp* to avoid bending the pointer, as the pointer is directly in front of the lamp. The phantom illustration, Fig. 20, shows the easy method by which a lamp may be removed or replaced.

CHAPTER XI

DIAL MARKING

Practically all a-c. instruments (and some d-c. instruments) have non-uniform scales, and the spaces between cardinal points vary greatly on instruments of the same capacity, so that printed or pre-marked scales are not practical. For this reason, blank scales are used and enough calibration points are marked in by comparison with an accurate standard. In the best manufacturing work, these points are accurately put in with pencil and then marked permanently with pen and ink.

One method of marking dials is herewith given with an explanation of the supplies and equipment necessary for the task. A small drawing board, Fig. 1, with pins for lo-

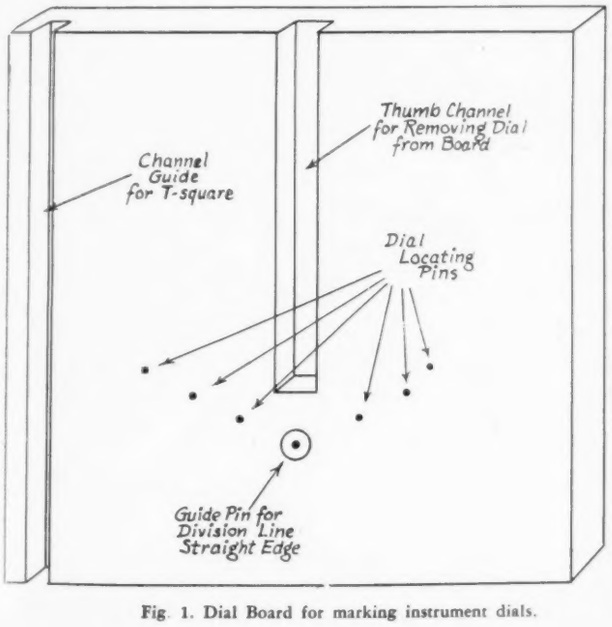
Thumb Channel for Removing Dial from Board
Channel Guide for T-square
Dial Locating Pins
Guide Pin for Division Line Straight Edge

Fig. 1. Dial Board for marking instrument dials.

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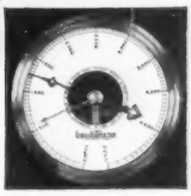

100% automatic—these gauges insure accurate readings at all times. No pumps, valves, or auxiliary units required to read them. Models available so that readings can be taken remotely from or directly at the tank. Remote reading types utilize balanced hydraulic transmission system which completely compensates for temperature variations on communicating tubing. Accuracy unaffected by specific gravity of tank liquid.

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cating the dial is used, along with a T-square for lining up the numbers or titles necessary. The board should be so arranged as to have an insert or locating pin at a point centered with respect to the scale arcs. This pin is to guide the straight edge or ruler used in marking the scale (See Fig. 2.)

The first operation in marking the dial, assuming the cardinal points are pencil marked, is to prepare the scale for taking the ink. This is done by pin-sticking all the pencil points and thoroughly rubbing the dial with an eraser to clean and remove any surface material that might prevent the ink from adhering to the dial, as well as to roughen the enamel surface to allow the ink to flow into the enamel. When thus preparing the dial, use a soft eraser and always rub in the same direction and go over the complete dial. If the dial is only partly cleaned and is rubbed in a criss-cross manner, the eraser marks will show and unfavorably affect the dial.

We next place the dial on the marking board as pictured in Figs. 1, 3 and 4, and mark in the main scale points. The pin is used as a pivotal point for the straight edge to assure that the scale division lines are positioned at an angle of 90 degrees with respect to the scale arcs. For the use of a number three "Speed Ball" pen, the main divisions (approximately 1/16" wide for large switchboard instruments) may be marked with one stroke. The use of this type pen also assures that all main lines will be of the same width, thereby improving the appearance of the scale. The straight edge or ruler used to mark the division lines should be marked to show the height of main and intermediate lines to guide the dial marker in making the lines equal in length. Another means of insuring that the main and intermediate lines are of equal length is to scribe light pencil arcs above the scale arcs to the desired heights. This may be done with the compass shown in Fig. 3, using the guide pin insert mark as a center point.

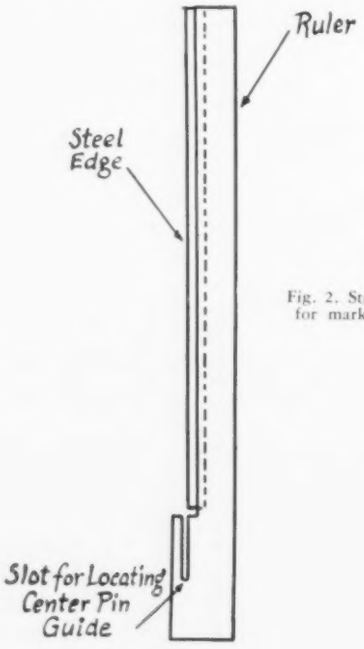

Fig. 2. Straight-edge or Ruler for marking division lines.

The next step is to graduate the scale between the mains for intermediate and subdivisions. It should be noted that when locating the intermediate and subdivision points of an a-c. non-linear scale, the spaces should be increasing or decreasing in accordance with the pattern of the scale. Intermediate and subdivision lines are spaced by eye for alternating current instruments, while for direct current instruments, dividers may be used as the spacing is even. For uniformity of division lines and ease of marking, the intermediate lines should be marked with a pen having a nib the width of the line desired. A pen of this type (Speed Ball #5) is shown in Fig. 3. Good results will be obtained in marking the subdivisions and calibration data with a round-pointed "Quill Pen #102."

The numbering arrangement on the dial is important from both the standpoint of appearance and the proper placement. How often have you seen a dial where the numbers were so placed with respect to the division lines that it was difficult to decide which mark was indicated by the number. To offset the possibility of misplacing the numbers with respect to the points to which they correspond, a small T-square is lined up in the slot shown on the left side of the dial board and may be moved across the scale with uniformity by reason of the close fit in the slot. The slot also serves to hold the T-square reasonably firm to avoid unevenness of number positioning due to change of position of square while making number impressions.

The number impressions are made with rubber type which can be made by any local rubber stamp maker by giving him a sample, either on a dial or a tracing of the number. Impressions are made on white dials with impres-

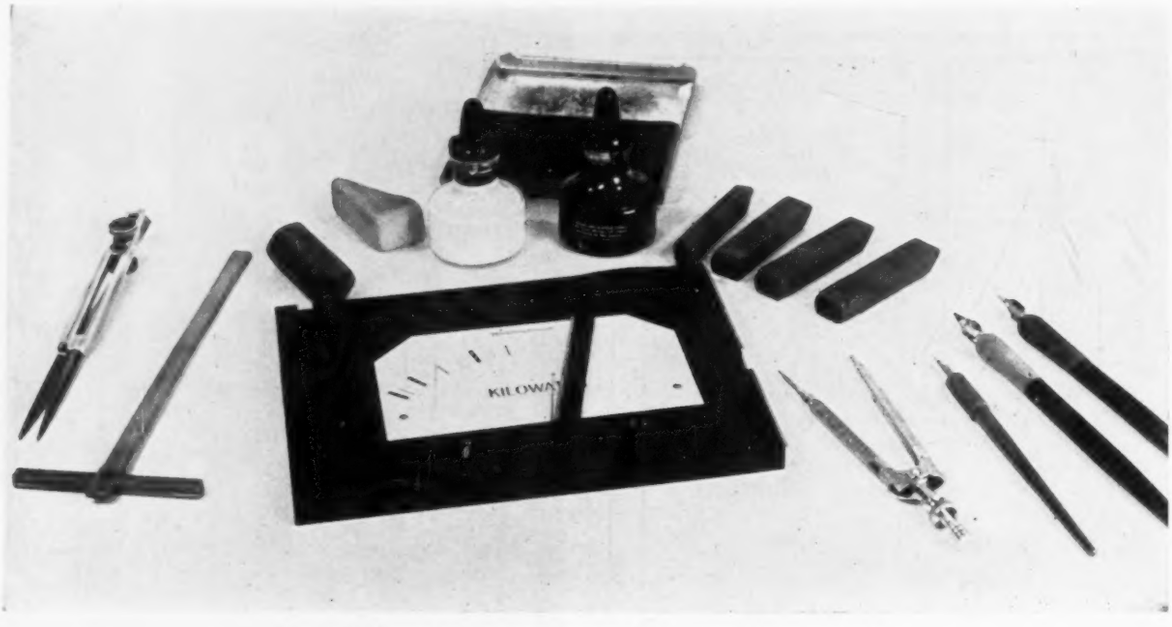

Fig. 3. Equipment and materials suggested for marking instrument dials.

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sion ink used on an ink pad; on black dials, powdered white chalk is used.

Inking in the numbers with water-proof India ink is done while the impression ink is still moist and can be accomplished satisfactorily with a "Crow Quill Pen." When the ink has dried sufficiently, the entire dial may be erased with a cleaner or art gum type eraser that contains no grit or sand.

The impressions on black dials are made with powdered chalk and dusted to remove the surplus chalk powder before filling in with show-card white paint diluted to ink consistency with warm water. To guard against the white ink flaking off the black dial, a light spray of a good clear lacquer should be applied. The lacquer is best applied with an atomizer but may be brushed on if done lightly and evenly.

Added titles or sub-titles are often desired on a dial to indicate some special information. This title work may be done by the same method as in the numbering, that is, by impression and fill-in. Here again the T-square may be satisfactorily used to line up the lettering evenly.

When finally cleaning the dial, a soft sand-free eraser should be used. The rubbing stroke should be the full length of the dial and always in the same direction. This results in a clean dial, devoid of eraser marks that detract from its general appearance.

If it is necessary to remove the India ink to make corrections, the eraser should be moistened with water for best results. The moisture loosens the ink from the dial and makes complete removal of the ink easy, leaving the dial clean and ready for remarking.

The two most troublesome conditions found in dials are discoloration and ink flaking. The first-mentioned fault may be due to chemical mist, gases or fumes attacking the dial or it may be due to a poor enamel coating. Reliable instrument manufacturers now produce lacquer enamel dials that retain their whiteness over a long period of years and are not readily affected by common gases, fumes or mist. Heat, light and darkness were also enemies of the dials of yester years and of the present-day dials of some manufacturers. As regards flaking of the ink, this is usually the result of improperly eraser-cleaned dials or a poor type of ink. If a good quality ink is used and the dial is properly prepared (erased and roughened) to take the ink, flaking will not take place.

Instrument manufacturers are often called upon to supply a new dial for an instrument recalibrated in the field, or where transformers are changed and a different scale marking is desired. Two suggested methods of supplying the necessary information to enable the manufacturer to supply accurately-marked dials are as follows:

(1) If the positions of the scale points are changed due to recalibration, mark the new calibration points with a pencil, remove the dial and send it to the manufacturer with as much information pertaining to the change as possible.

(2) If the instrument cannot be taken out of service, make a tracing of the scale as accurately as possible and send the tracing to the manufacturer along with all the information noted on the dial.

From either of these two methods, a new scale may be drawn and returned to the user. This procedure is not recommended for portable instruments, as the possible errors of calibration with this method might excel the close tolerances expected of portables.

Suggested equipment and materials used successfully in dial marking (some shown in Fig. 3) are listed below:

(1) Ordinary sewing needle for pin pricking calibration points.

(2) "Rub Clean" #6002 Eberhard Faber eraser for preparing dial to take ink, and cleaning.

(3) "Speedball" pen #3 for main division line marking.

(4) "Speedball" #5 for intermediate line marking.

(5) "Hunt Quill Pen" round pointed #102 Hunt for subdivisions, small lettering and impression fill in.

(6) Stamp pad used with "Dri-Kwik" ink for rubber stamp impressions.

(7) Dividers for spacing d-c. dials.

(8) Blackboard white chalk for impressions on white dials.

(9) "Ace Show Card White" diluted with warm water for black dial marking.

(10) Higgins "American India Ink" for white dial marking.

(11) White French lacquer for spraying black dials.

(12) Compass for scribing arcs.

(13) Rubber stamps for making number and letter impressions.

(14) "Weldon Roberts" cleaner type eraser #1010 for final cleaning.

(15) Dial board with guide pins as shown in Figs. 1 and 4.

(16) T-square for lining up numbers, titles, etc.

(17) Straight edge for marking division lines.

(18) Brush for cleaning.

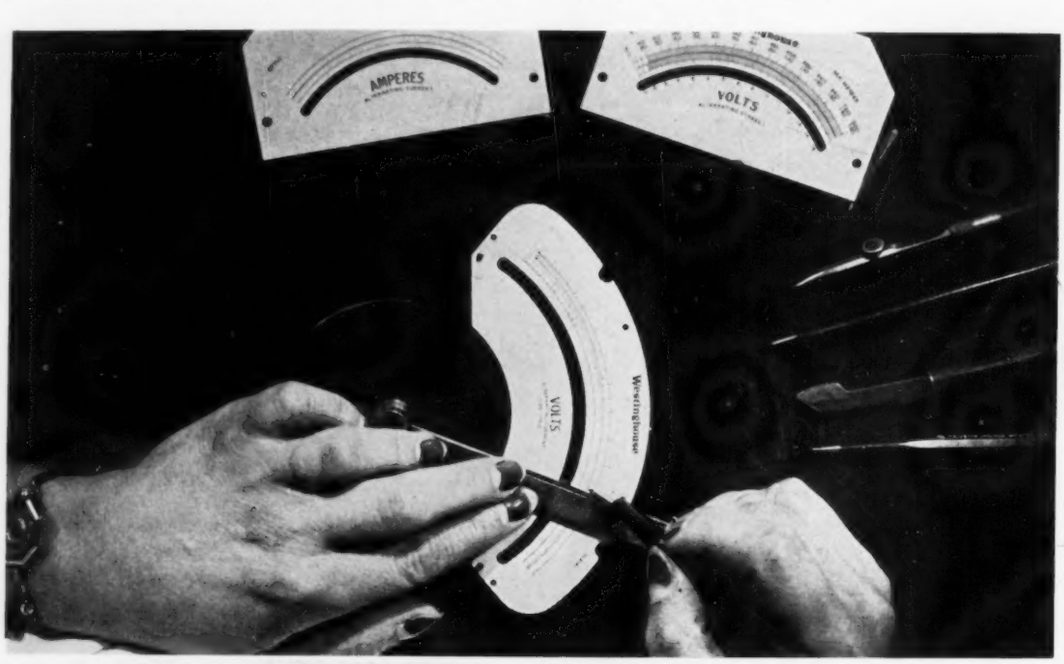

Fig. 4. Proper method of marking scales with equipment shown in Fig. 3.

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2. Metallized Type Resistors: Insulated ½-, 1- and 2-watts; high frequency power, high-voltage power.
3. Insulated Wire Wounds: Type BW from ½- to 1- and 2-watts; Type MW, 5 to 20 watts.
4. Power and Precision Wire Wounds: Fixed and adjustable power types from 10 to 200 watts in all shapes, mountings, etc. Inductive and non-inductive. 14 Precision Types to as close as 1/10 of 1% accuracy.
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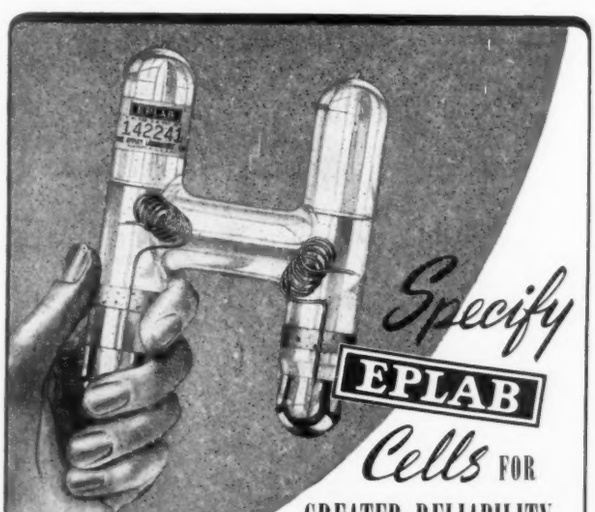

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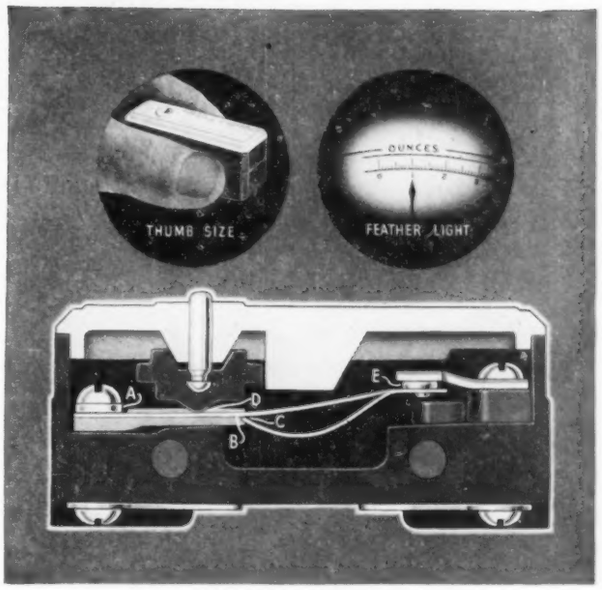

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- **Longer switch life than you will ever need**
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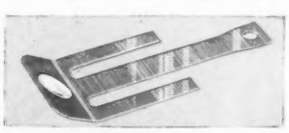
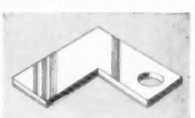
- **40 grams contact pressure—lightning-fast contact action**

The Micro Switch design incorporates features that provide desirable performance characteristics not generally found in snap-action switches . . . The heat-treated beryllium-copper spring bends in the same direction as the operating plunger—no reverse bends—no "oilcan" action . . . gives longer switch life—accurate repeat action—increased contact pressure—lightning-fast action—millions of operations on minute movement and force differentials. It is the choice of design engineers for all types of sensitive instruments.



The beryllium-copper spring is made in one piece. It is gauged to an accurate .0085" thickness; has high resistance to fatigue. Ends of compression members are finished to provide an extremely low friction bearing. Contact end of the spring is fitted with a riveted radius type contact of 99.95% fine silver. It moves at a speed of 3/1000ths to 5/1000ths of a second with a rolling action and extremely high pressure.

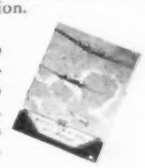
Short spring members pivot in patented V-grooves of this sturdy brass anchor. Note the special shape of these grooves, which reduces friction to a minimum.



Stationary contact is a flat inlay of 99.95% fine silver. This construction assures ample over-load capacity and maximum heat dissipation.

Operating plunger is a highly polished stainless steel pin imbedded in an accurately moulded star-shaped Bakelite head. Provides long over-surface path to live parts, thus insuring freedom from electrical leakage. Plunger head cannot rotate within the housing, insuring against any variation in point of operation.

If you would like to know more about the Micro Switch, send for the two Handbook-Catalogs illustrated here—No. 60, which covers Micro Switches in general; and No. 70 which deals with specific Micro Switches for use in aircraft.



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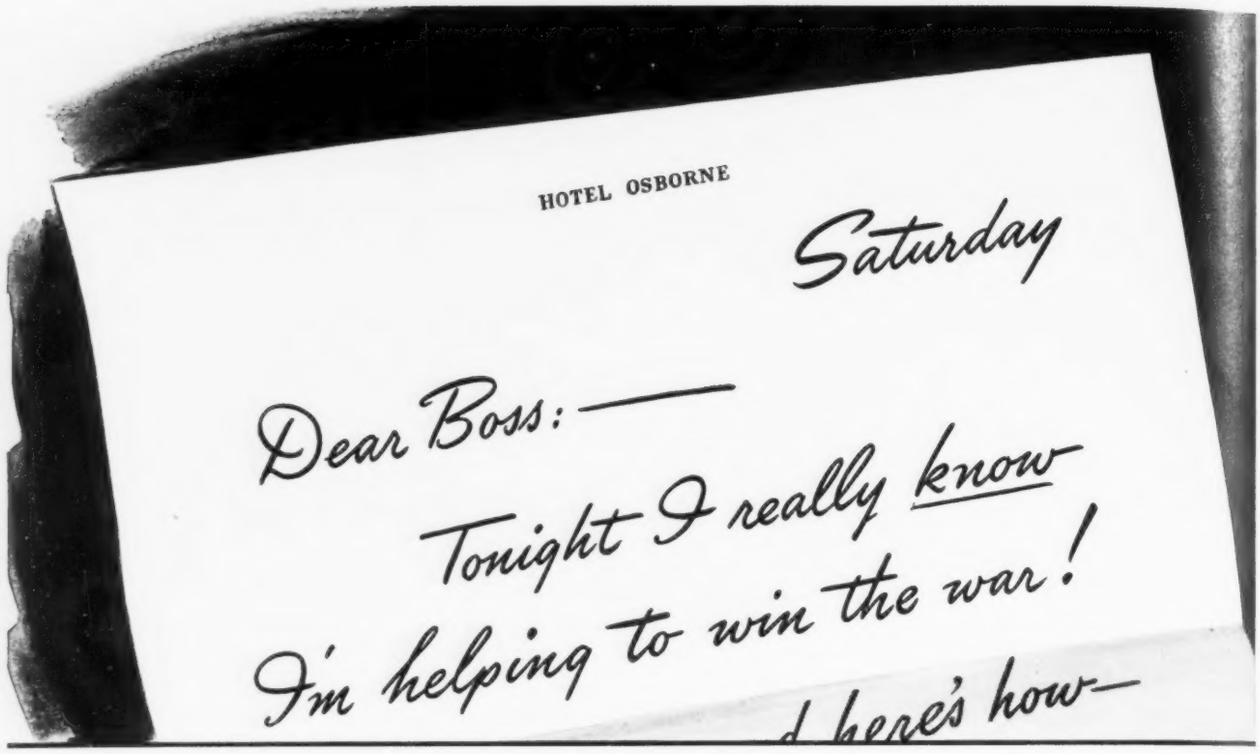
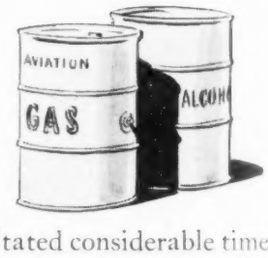


Long before Pearl Harbor, I realized that I and the 75 other Taylor Field Engineers would play a mighty important part in helping industry expand to meet war needs. But for the last four months I've been keeping a diary—and reading it over tonight it came home to me for the first time how much we're all actually helping to win the war!

When you figure that this is a war of production—and that so many production jobs depend on Taylor instruments—and that it takes a man who not only knows the instruments but knows how to apply them to each particular job—well, just let me give you a few examples and you'll see what I mean:

You know the _____ Oil Products Company? They make impregnating materials and industrial alcohol. Their problem was the processing of wax and other chemicals to meet immediate Government contract requirements . . . the success of which depends on a rigid cycle of time and temperature control by Taylor instruments. These instruments could not be satisfactorily adjusted by written instructions, and necessitated considerable time and knowledge of both the processing requirements and instrument functions before the required control was established. Manual control without the instruments would have slowed down the processing and caused mistakes.



Or take the pulp and paper industry. At the _____ Paper Corporation I placed in operation 18 beater roll control systems which maintain proper roll pressures on the pulp in accordance with a time schedule. At the _____ Bag and Paper Company, I inspected instruments in operation, made adjustments, and recommended new installations. The result in both cases was increased production and improved uniformity.

At the _____ Battery Company I specified instruments for indicating temperature of pitch and

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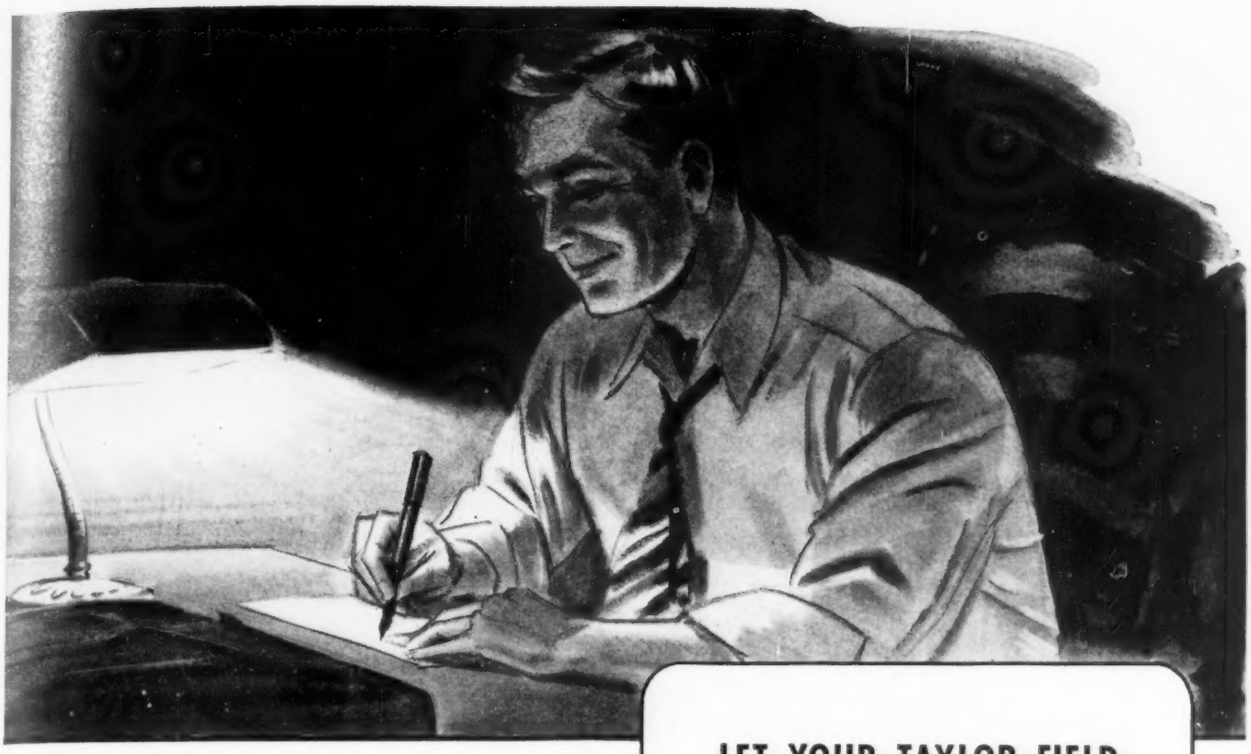
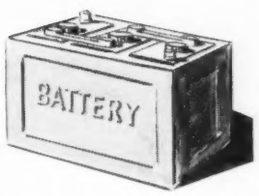


lead tanks. At the _____ Mills, making government cloth, I made a survey of dye plant controls, including adjustment and repair of 3 instruments not operating properly. At the _____ Canning Factory I installed automatic retort controls for the processing of glass packages. Like every other canning factory these days, they are faced with a shortage of tin. Without such controls as we are able to furnish, it would be almost impossible for them to process glass packages.



But the one thing that impresses me in all my contacts with wartime plants is the enthusiastic welcome I get. I seldom have any trouble getting to the men I want to see—in fact *they're* the ones who usually want to see me! It sounds like bragging I know, but I honestly feel that today we Taylor people are doing a job! And when you really know you're helping to win the war—well, it's a grand and glorious feeling!

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Vol. I, No. 2 GUEST EDITOR: R. G. OJERS July 1942

Importance of Aircraft Instrument Mechanics in War and Peace

Editorial by R. G. OJERS, Chief Instructor, Instrument Department, Spartan School of Aeronautics, Tulsa, Oklahoma

WITH superhuman accuracy our pilots are enabled to guide their huge ships of the air unerringly over thousands of miles to destinations which are kept secret from all but a few chosen men ordered to draw up a flight plan to an objective, execute these orders and return. Their routes are not like the marked airways we have become accustomed to—laid out with brilliant beacon lights every few miles, directional beams and dispatchers to help them find their location through radio triangulation—not like those paths over which repeated flights cause us to know and recognize landmarks that make getting lost an impossibility—but they may be courses that may be set in any one of the 360 degrees of the compass.

The compass is only one of a myriad of instruments necessary to this journey. The radio that has been a boon companion in all our pre-war flying days is still useful but cannot be used much as it may betray our location. So it is necessary that we rely entirely upon our instruments.

To the layman, this expression "instruments" is used in many different fields. In the aviation industry, our instruments are narrowed down but still cover a wide area, from types used to make drawings for the original aircraft, to others for testing materials, gaging parts, and setting up dies, jigs and templates for its construction. There is really no end. But to concentrate on the ones now under discussion, let us group them thus: (1) engine instruments, (2) flight instruments and (3) navigation instruments.

R. G. OJERS was born in Horton, Kansas, in 1905, but his family moved to Chickasha, Oklahoma, when he was a year old. Eight years later he received his first aviation thrill by attending an aerial "exhibition" — one plane which had been shipped to Chickasha by freight, put together and flown, then was dismantled and again shipped by train elsewhere. Feature of the exhibition was bombing a "fort" with bags of soot, guided by tiny copper cones with propeller tips. Ojers and his brother found one, which became their pride of possession. All airplanes were eyed enviously from then on. At the age of twenty, after moving to Hastings, Nebraska, Ojers made a parachute jump to get his first ride with the Paige Flying Circus of Lincoln, Nebraska, using the exhibition type 'chute that is outlawed today. The following year another flying circus came to town to start a flying school. Ojers was the first and only student. The school staff "folded their tents like the Arabs and as silently stole away." Thus ended his flying career! A few years later he got married and, after studying and working as a watchmaker, joined TWA in Kansas City. No one knew much about instruments and it took a lot of pioneering and two trips to New York a year for five years, for necessary information. He was later asked by Captain Balfour, Director of the Spartan School of Aeronautics, to set up an instrument department and school. Now they have an additional department, separate from the school, for major overhaul and repair of all instruments from the simplest pressure gages to the most elaborate automatic pilots.

It is difficult to draw a sharp line between the last two, as they are closely associated, but it takes perfect co-ordination of all three to get the job done. The manufacturer must design precision instruments and build them in mass production. His instruments must in turn be installed by the aircraft manufacturer's experienced men, but the skill and experience of these two groups would be more or less useless without the devotion of the aircraft instrument overhaul mechanics. These instrument mechanics must know their instruments from cover glass to the master plate that holds the wheels, sector gears, pinions, bearings, jewels and —in the Sperry group—the ball bearing assembly and pivots. They must know the tolerances and fits. Last but not least, they must know the various methods of testing and calibrating. On this subject, volumes could be written.

A peculiar fact is that every foreman has his own idea of how to test and calibrate instruments and (to a certain extent) disclaims all other methods. Back in our own minds we all have a smug feeling that we pioneered our own methods and that they are the best. But, just like belonging to various churches, believe it or not, all our teachings will bring our human subjects to an ultimate end: they will either be good mechanics or fall by the wayside, as this is one field where there are no back-sliders—not for very long at a time, anyway.

Considering the gigantic strides we are making today, now more than ever speed is required in everything we do in order that we may not only keep abreast but stay ahead of developments and it rests with us of the older school with the newer members of our profession or guild, to create not only the new equipment but locate concerns that can build for us our own creations with speed necessary that they may be put to use immediately. As an illustration, the writer is working in conjunction with an instrument testing laboratory here in Tulsa that may entirely revolutionize quite a few of the older methods of testing, eliminating a lot of errors that are apparent and will lead to a much more accurate indication and be more simple to gain the peak of efficiency so vitally necessary to the demands of the true piloting of our own advanced flying of today. This is still on paper but we hope we can have it in this magazine sometime in the future. Also, if we have ideas now in use in our shops, schools and factories, let's bring them to the front for the sake of aviation and, above all, for our government, that we may "get there fustest with the mostest."

Our particular skill is little known and we are the only ones that can remedy this condition. In the earlier days, our big job was to convince the pilots that in order for them to fly under all conditions, it was necessary they use instruments. We then had to prove to these pilots that the

instruments could be overhauled to the point where they could be depended upon. They had to have confidence in our ability. This we have accomplished. The public, however, is becoming more and more air-minded. They should know more about the behind-the-scenes activities — the manufacturers' activities and especially the story of research from the days of the earliest aircraft instruments; also their use, operation, quality and the constant search for better, more accurate and less expensive units for the modern "common" or "sportsman" or private pilot.

The public should know more about America's constant endeavor to beat the other countries that our nation may have the best. Then we mechanics will show our ability to keep abreast of all this development by suiting our words to action and "Keep 'em Operating."

The war emergency has created problems in all walks of life. Ours, like others, have been hit. We have trained a lot of men in this phase of work, but all the schools now in existence will still miss our goal of complete mastery of the situation by a long way. Most of our schools in this country do not claim to make finished mechanics, but, from a bona-fide and qualified school of 1200 hours we can make better mechanics than a two-year course of apprenticeship; and this is important in these days, when there is such a tremendous emphasis on *speed*—speed of production of war goods and speed of training practical mechanics. The drain on our manpower, plus the rapid growth of war industries, is creating a keen desire for this type of work on the part of those who know that this will be well accepted long after the war will have been won, due to the upward trend of aviation which is certain to become a major means of transportation for both passengers and freight, to rehabilitate all the war-torn countries. This all bears out that recognition must be given to conditions other than constructing our invincible war machines. Our extreme effort for ultimate victory must be motivated and dominated by engineered plans to perpetuate those fundamentals of human values, that otherwise can drop us in the most horrible of depressions known to mankind. It behooves us to consider this well.

Let's Get Together

Proposing a Guild of Aircraft Instrument Mechanics

I HAVE HAD any number of inquiries from our students scattered all over the country, as well as old-time mechanics and department heads, asking why an Instrument Guild has not been started. Not a union, but a guild—that we may exchange views and ideas to enable us to help one another be better mechanics for our employers, whether they be the government, commercial or private organizations. And I believe with the right kind of response to this magazine, they will act as a medium for each of us.

This industry is advancing so fast and the various jobs are being specialized to such an extent that it is difficult for one of the "standard group" aircraft instrument mechanic to know much about the happenings in the "Sperry group," and vice-versa. Furthermore, these groups are broken up into numerous divisions; and some of these are electrically operated—which will create a demand for electrical knowledge that we old-timers will have to study and obtain from some of the newer mechanics.

So you see we will be dependent on them as well as they on us.

Incidentally, all this holds true as much for women mechanics as for men. We should not get the idea that women are stepping in to take our jobs. They will help us to do one job that is too big for us at the present, considering the scarcity of manpower.

Do not think for a minute there will not be plenty of work for all of us after this war is over. I have investigated this rather extensively, and have received definite assurances. It is true some will fall by the wayside. These will be laggards that would be washed out anyway as soon as various organizations can check their efficiency. But be sure you are not a laggard. I believe one way to help is, let's all pull together, let's get together.

The truth of the matter is that we all get our training from the ground up from the help and cooperation of everyone around us, from the newest man in our organization to the oldest mechanics, from articles we read, and from contacting other experienced mechanics, supervisors, executives, research engineers, designers and inventors.

It really takes complete cooperation from everyone mentioned above. Even from the new student mechanics we get pearls of wisdom that help us on in our never-ending and ever-widening search for faster and more accurate methods —methods of giving the best dependability to ease the strain on the pilots and navigators so they may utilize that much more time to the job of getting there and back with the greatest dispatch in carrying out their missions to the utmost.

Our deliberate choice of the term "guild" is really a story in itself. . . . In the early days, small groups of related families were known as tribes. Then several small tribes would band together to form a clan. Later, a few artisans, so to speak, from each tribe, would form a guild. As far as is known to historians, the first to be known and recognized were the makers of charcoal, a trade only a few knew at the time.

In the days of Cleopatra an old man gathered a few apprentices together and, with sulphur and phosphorus from rotten manure, made the first firebomb used by Thros of Somathrace in his conquering the seas. This was spoken of as a guild.

Today, one of the most popular—and also a very old one—is the Watchmakers' Guild, well established all over the U.S.A.

Any trade that is a trade in itself would be classed a guild. There is no other trade that will lead to an aircraft instrument mechanic, but if you are an aircraft instrument mechanic, you can branch out in several other trades without too much effort. As an example, there is an idea that if you are a watchmaker you can soon become an aircraft instrument mechanic. That is an erroneous idea because some watchmakers make aircraft instrument mechanics and others don't and can't. But if you are an aircraft instrument mechanic, you *can* be a watchmaker with a small amount of additional study! I know, because I was a watchmaker myself.

So my idea of calling this a guild is to band together a large group of new and old mechanics, pooling our ideas and methods, with the purpose of being one large body of artisans proficient in our own right.

Now as to the expression "societies." It is a matter of opinion, of course, but this term covers a multitude of sins and virtues, from those that deal in murder, vice and carnage, to those at the highest peak of religion. Societies are changeable and their creeds vary to a certain extent, with the moods of the personnel and the times, whereas a true guild is to bring everyone to a common goal of efficiency and a common opinion in a trade that is so vitally necessary to the field of aviation today and in the future.

I believe that if we make our wishes known to this magazine, they will cooperate 100% in helping us to develop our trade into a guild that we may all work together and think together, knowing in the end we are accomplishing in a big way an objective laid down to us, not as a scattered group of mechanics, but as a unified machine built solely to aid our government and nation to the utmost, that we may do our part to win this war with colors flying high and to know a bigger and better future to aviation than has ever been dreamed of, in spanning the entire world in less time it took our parents to migrate from Kentucky to Oklahoma.

If this appeals to you, make your wishes known and we will see what can be done about designing a pin or ring, and about assessing small dues for handling correspondence, postage and, of course, research to answer the questions you may wish to know. —R.G.O.

Instrument Flight—The Bomber Pilot Speaks

An article—not an account of any particular mission performed by the author

By FRED S. KRAMER
Ground School Instructor, Spartan School of Aeronautics, Tulsa, Okla.

WE had just left our base, flying on sealed orders to be opened at Position B-10-C (First Observation Point), when the weather began to close in. We were flying at 10,000 feet and would have no radio aids for the remainder of our flight.

My co-pilot was checking his log books. The rest of the crew were at their stations. Their equipment had been checked and double-checked. All they had to do now was routine work to them.

I started a climb on instruments, maintaining a steady course and, at 22,000 feet, I checked the inter-communications and found everything and everyone O.K. Then I settled down to the routine of flying entirely by instruments. Ours was a four-engined heavy bomber and we had a load of explosive air express to deliver to a central European country. In such an airplane, one has approximately one hundred and ninety instruments, cranks, knobs, push-buttons, pull-buttons, toggle switches and handles to observe and to operate at some stage or other of the flight. There are many more, but the radio operator takes care of his share and the navigation officer helps by giving the correct course on which to fly. The chief pilot and the co-pilot share the responsibility of actually flying the airplane, operating the engines and checking their performance and the progress of the flight by the various instruments available for the purpose.

GLENN L. MARTIN CORP. PHOTO

In some of our large trans-ocean flying boats, the task of supervising engine operations is relegated to the engineer officer, who has a panel of thirty or so instruments which indicate every beat or irregularity of the four powerful engines. He also controls the performance of the engines, so that they work at their most economical speed.

The co-pilot, flight engineer and myself had the responsibility of the operation of the plane, while the rest of the crew had their work cut out as to navigation and protection from the gun positions.

The radio man could only "listen in," as by this means we could pick up information transmitted by the enemy, which may offer us valuable help in performing our task.

. . . And now we have accomplished our mission and are returning to our home base. It is just as important that we get our big ship back safely, as the loss of an airplane and its crew may be a serious predicament to a squadron.

It is still overcast and, on our way home, we have to fly entirely by instruments.

The procedure is simple, but it takes much practice and no mean power of concentration. The basis of it all is, not to let the airplane assume any attitude other than the one you wish to maintain. Since your blind-flying instrument panel contains several important instruments, a certain routine has been adopted. The prime function of the blind-flying pilot, then, is to observe three things: the needle of the turn indicator, the Sperry auxiliary horizon indicator, which is nothing more than a horizon inside the cockpit, and finally the airspeed indicator. This must remain constant and the pilot then knows that he is flying level, i.e., that he is not climbing or letting down. This combination is drummed into the ears of each and every blind-flying student, and those who remember it find no trouble in negotiating their course.

The weather had been bad during most of the trip, but now it became positively vile. Violent rain beat on our windshield. Occasional flashes of lightning burst in upon us and the air was gusty. This made instrument flying rather difficult, because all the instruments perform the St. Vitus dance, but the automatic pilot was performing beautifully, which made our job a lot easier and gave us more time to check and double-check our course while watching the operation of the engines, which so far had given us no trouble.

During all this time we could see nothing of the ground, but that was relatively unimportant.

Our navigator was navigating by dead reckoning and would later use his sextant to shoot our position, as soon as we could see the stars. The thunderstorm gave out after about an hour, after we had climbed to 26,000, where we broke through the overcast. It was glorious to float along above that vast set of billowy white clouds, with a bright moon illuminating this fairy landscape.

Our navigator took several sights with his sextant and, a few minutes later, his information came to us over the innercommunications phone.

We were on course and it was plain sailing.

Suddenly the radio operator gives a signal and we listen intently . . . Enemy action!

I turn our situation over in my mind. We have three courses open to us. I choose the one that appears to me to be safest. I change my direction and intend to hold it, until reasonably sure that we are out of the danger zone.

That must have been one enemy ship conversing with another. That was a narrow escape.

We keep the new direction for one hour, during which we hear nothing further over the radio, except a lot of static. My navigator tells me the new course, which will lead us home. Our trip has been successful.

Dawn will find us at home. Only two hours to go.

It should be safe to let down now. There is still that uninterrupted blanket of clouds beneath us. We disappear in it at a shallow angle. It is cold. The cold before dawn.

I am back on instruments at 18,000. I find icing conditions. Not pleasant but everything is under control. My de-icers work perfectly and 3,000 feet lower we run through warmer air which eliminates the ice. We are back at low altitudes, but still in the overcast.

The navigator reports that we should be exactly over our base. I start spiraling, long shallow spirals. One never knows what is below.

Suddenly, at 6,000 feet, we break through and there, only a mile away, is our base. They have heard us and we land, happy in the thought that we are at home once more after nine hours of continuous flying.

Our airplane and our instruments, were as reliable as I had expected them to be. It is rare that your instruments will let you down.

Intensive Training Relieves Critical Bottleneck of Aircraft Instrument Overhaul

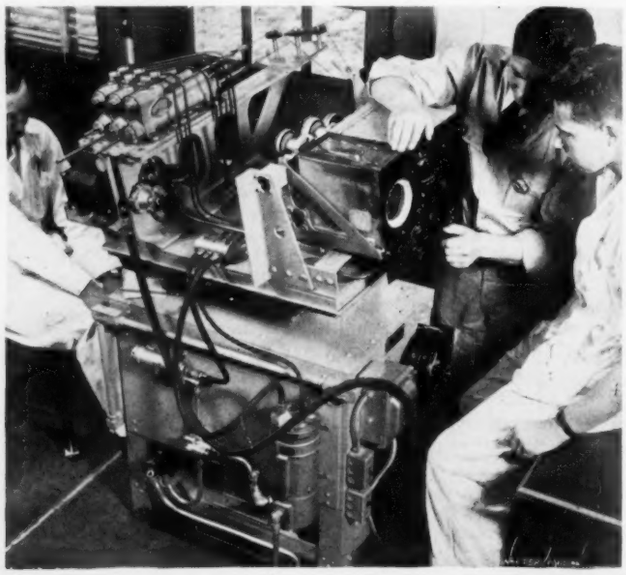
By R. G. OJERS

Chief Instructor, Instrument Dep't, Spartan School of Aeronautics

WHEN a country is unprepared for war, the selection and training of millions of human beings and their allotment to responsibilities for which they are best suited becomes an urgent problem. The rapid increase in employment by aircraft companies has created an immediate shortage of skilled workers. A few of the old-line schools were prepared to take care of a small part of this work and to those schools were immediately added hundreds of others of which a large majority have done excellent work in preparing men and women for employment. Naturally the great majority of these schools chose the fields in which they would need to invest a minimum for equipment and highly skilled personnel. For that reason, there are only about a dozen schools teaching aircraft instrument overhaul. The cost of a completely modern and thoroughly-equipped instrument overhaul laboratory is so great that only a few are willing to risk the investment. Furthermore, only a few operators knew where to find the necessary skilled personnel to establish such a school and make it successful.

There is also the problem of selling the prospective student on the need for skilled instrument mechanics. Few people realize how much maintenance work is required to keep aircraft instruments functioning as they should. It had long been the custom to return all instruments to the manufacturer for repair work. Today the manufacturers are swamped with enormous orders from the Services and they are more than ever anxious to have repairs handled by private operators, airlines, or the Civil Service depots. The result is that the field of instrument repair is suffering more than any other from a shortage of skilled and semi-skilled labor.

Until a few months ago it was common opinion that the type of candidates from among whom a school could create aircraft instrument mechanics must necessarily be obtained



Top, left.—The Chief Instructor of the Sperry class explains to one of the students the procedure of centralizing the gimbal ring in a vertical ring of a Sperry directional gyro while the other students look on.

Top, right.—A student watches, through the actions of the Scorsby Oscillator, the results of approximately one hundred hours of work by him and his partner. In the Sperry classroom, as well as in the standard instrument classroom, it is essential that students have sufficient precision jigs and testing equipment to enable them to know when they have really completed a worthwhile job.

Bottom, left.—Two students, assigned to the Bank and Climb unit of the automatic-pilot, prepare to set up to take the part readings after they have lapped and indicated to within one ten-thousandth of an inch the gimbal ring or aileron plate.

Bottom, right.—With the use of the Pioneer Master Tachometer, several engine-speed indicating instruments may be calibrated accurately and with dispatch.

Top, left—By performing tasks with our hands, we learn to co-ordinate thought to action in handling gyroscopic instruments.

Top, middle—Using the latest type Pioneer Turn and Bank Tester, whereby as many as five instruments may be calibrated and tested for friction in a few minutes.

Bottom, left—Ample testing equipment in the standard instrument classroom permits each student to carry on under his owner power. Making small parts is part of the training.

Top, right—Only two students at a time are assigned to a unit of the automatic pilot. Here two prepare the directional-gyro unit, after overhaul, for calibration and test on the Scorsby.

Center — Proper testing equipment proves a mechanic's skill. Mrs. Betty Ann Hillerman is proving hers.

Bottom, right—Each student in the standard instrument classroom is assigned complete instruments, to disassemble, recondition, clean, reassemble, calibrate and test.

from other mechanical pursuits, particularly from the field of watchmaking. That theory has now been discarded. Spartan School alone has furnished hundreds of good instrument mechanics to the airlines, to the Civil Service, to the factories and to the military Services. These people came to our school from every walk of life. We have trained oil field workers, drug store clerks, shoe clerks, morticians, truck drivers and ranchers. We have trained housewives, mothers and school teachers. We have yet to hear of a single graduate of this school being released from employment because of lack of skill.

An instrument technician must be taught not only how to overhaul his [or *her*] instruments but must know the principles of operation and the theory of modern instruments and of those to come in the future. These people must, due to the rapid improvement and changes in instruments, be ready for the new developments of tomorrow. They must know and recognize quality tools and know how to take care of them. A good instrument mechanic must recognize the problems faced by the pilot and the airplane owner, he must satisfy his customer. When he can do this, no matter where he has been trained, he may expect recognition as a trustworthy and excellent instrument mechanic.

He . . . or *she!*

Precision Test Equipment Required for Aviation Instrumentation

By GLEASON W. ZINK

President and Designing Engineer,
Aurora Instrument Laboratories, Tulsa, Oklahoma

IF WE accept Webster's definition of instrumentation: "a use of, or operation with instruments," we can readily see the close tie-up with aviation. It has been said that this war will be won with instruments. With instruments playing such a vital role in the future destiny of our Nation (or perhaps it would be better to say in the destiny of our friends and loved ones) it behooves us as technical men to spend long hours in our laboratories improving our methods.

With this in mind, we should start with our gages for dimensional control and laboratory test equipment for microcontrol of the delicate forces which actuate the instruments which we are required to test. Modern manufacture of interchangeable parts, of course, would be impossible without precision gages watching the tolerances. We have a direct parallel in our effort to make a number of gages or instruments read exactly like the standard. This, of course, entails having test equipment far more accurate than that which is expected of the instruments. Most precision test equipment must have individually calibrated dials, that is, dials calibrated in the designer's laboratory from a still more highly sensitive or accurate master, consideration being given to temperatures, capillary, specific gravity and other factors which would have their effect, then rechecked to assure that no error has been made in calibrating. Test equipment having etched or prefabricated dials should never be used without checking their accuracy with some known standard. This, of course, is good practice on all test apparatus. The careful technician will check his test equipment at regular intervals to assure that no hysteresis or mechanical defects have appeared to affect the readings.

I sincerely believe that the greatest field for the young man of today is in the field of improving our aircraft instruments. Stratosphere flying opens a whole new field to the instrument technicians. Today's plane of the stratosphere not only requires precision instruments but test equipment for the temperature requirements as well. Today we are developing and improving these highly precision marvels so that man may fly ever higher and faster. It is not too much to expect that tomorrow our sons will be toying with instruments for interplanetary navigation. But today, we have a war to win. Our war machine is no better than its control instruments.

SHOP NOTE—SCREW SIZES

HERE is a test to make in your department. Take several small instrument screws and ask any of your fellow-workers to explain to you how to designate their sizes. Believe me, I was surprised when I tried it: very few knew outright—even old machinists. Most would say "What part of the instrument does it go in?" (They would know the size of the screw that belongs there.) Some old-time machinists answered "You can tell just by looking at it."

The accompanying chart is for those who do not know—and in this newly developed field of instrument mechanics there are a lot of recruits. Honest confession is good for the soul. I was a recruit for almost five years before I could tell anyone else how to do this. Like anything else, it is simple after you know how. First find the body diameter with a micrometer. This will give the size. Then with a screw pitch gage, find how many threads per inch. As an example, if the body diameter measures 0.086" (eighty-six thousandths) the size would be No. 2. To help you find the threads per inch, you read across from No. 2 and in the second column of figures you find 64. But check with your thread gage to be sure it is this number. Do not rely upon a chart for your threads per inch, as for example, there are both a No. 4-40 screw and a 5-40. Also a 2-56 and a 2-64. —R.G.O.

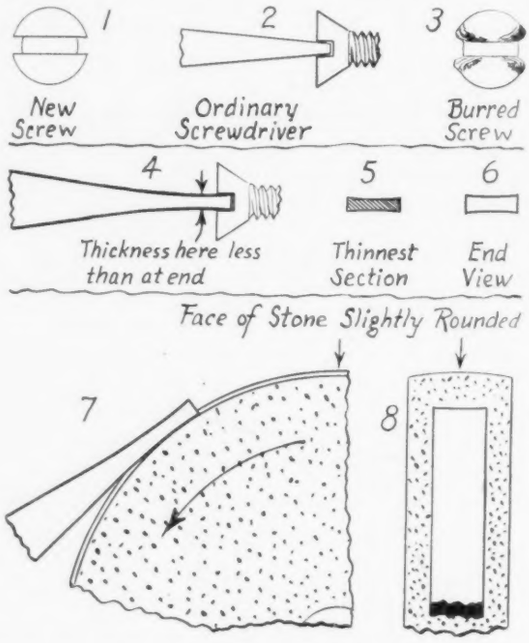
INSTRUMENT SCREWS

No.	Threads per inch	Body Diam.	Tap Drill No.	Tap Drill Diam.	Body Dr. No.	Body Dr. Diam.
0000	160	0.021	80	0.0135	73	0.024
000	120	0.034	73	0.024	63	0.037
00	96	0.047	66	0.035	55	0.052
0	80	0.060	56	0.0465	52	0.0635
1	72	0.073	53	0.0595	47	0.0785
2	64	0.086	50	0.070	42	0.0935
3	56	0.099	46	0.081	37	0.104
4	48	0.112	43	0.089	31	0.120
5	40	0.125				
6	40	0.138	33	0.113	27	0.144
8	36	0.164	28	0.1405	18	0.1695
10	32	0.190	20	0.161	9	0.196
12	24	0.216				

S.A.C.T.D. No. 725

SHOP KINK—SCREWDRIVERS

BIGGEST bugaboo of all airlines, factories and private owners is burred screws showing like a sore thumb on the instrument panel and elsewhere on the plane. This can be eliminated 100 percent with little effort if the mechanic uses the hollow-ground screw driver. The illustrations herewith show how. Fig. 2 shows a new factory-made screwdriver and how it fits the screw slot. The twisting pressure necessary to tighten and loosen this screw will give it the appearance shown in Fig. 3, with sharp, ragged edges. Figs. 4, 5 and 6 show a new screwdriver, hollow ground. Note how it gets its purchase at the base of the screw slot, making it, with reasonable care, practically impossible to burr



a screw head. This can be applied to all screwdrivers, large or small. It may create the necessity of having about six screwdrivers aside from your jewelers set, but it is too easy for us to use one or two drivers for all size screws, which we know is poor practice. The hollow grinding can be accomplished as shown in Figs. 7 and 8. Use a power grinder, the wheel being of a large enough diameter to grind the contour necessary. If the proper size wheel is not available, it can be done with a smaller one, only it takes a little more practice. Use an old shaft of some kind until you learn the method. You will find the ease in handling and the decrease in number of burred screws will justify the effort. —R.G.O.

Happy Landings
WITH CANNON PLUGS

Whether it's the circuit for a flap position indicator, a gasoline gauge or a fuel flow indicator...it's an important circuit. These transmitters and indicators have an important job to do, and the connectors that carry these vital circuits must be just as reliable as the instruments themselves.

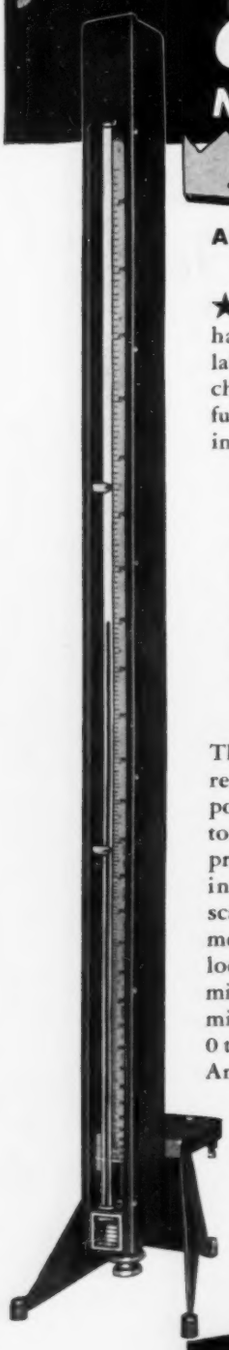
Cannon Connectors have the dependability to insure continued happy landings. That is why manufacturers of fine instruments demand these specialized connectors. Cannon Plugs, made in America's largest and best equipped electrical specialty plant, are backed by twenty-seven years of experience in this field.

Flap or wheel position indicator and the transmitter by General Electric.

CANNON ELECTRIC
DEVELOPMENT COMPANY
LOS ANGELES, CALIFORNIA

MERIAM

Announces THE "8 in 1" MANOMETER



AN AIRCRAFT INSTRUMENT TEST MANOMETER

★ This manometer, Model A-338, has an extensive application in laboratory and field servicing for checking calibration to determine functioning of aircraft instruments, in particular:

Altimeters
Air Speed Indicators
Rate-of-Climb Indicators
Fuel Pressure Gauges
Manifold Pressure Gauges
Suction Gauges
Automatic Pilot sylphons and actuating diaphragms; etc.

The instrument is of the direct reading well type design incorporating an eight sided scale selector, permitting the selection of proper scale for particular aircraft instrument being checked. All scales are adjustable to suit barometric conditions in any specific locality and are direct reading in miles per hour-knots-pounds-inches-millimeters, etc. The range is from 0 to 61 inches of mercury or water. An integral return well prevents loss of indicating fluid.

The manometer is fully described in Bulletin 22. Copy will be mailed on request.

★ ★ ★

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CLEVELAND, OHIO

Manometers, Meters, and Gauges for the accurate measurement of Pressures, Vacuums and Flows of Liquids and Gases.

What One Student Thinks

By C. I. PRITCHARD

BECAUSE I am both mechanical and air-minded, I have been waiting for the time to come when I could work in the air industry. Until recently I did not have the incentive to entirely pull up stakes and change from one trade to the other, but since the war has started, and due to my age and having a family, I figured the best way to serve a good cause was to make the long-anticipated change.

Being in the transportation game of trucking, I felt it was just a step forward to get in the transportation game of aviation. Instruments play such a vital part in the present and future air progress that I think this field has unlimited possibilities for me. It gives me an opportunity to serve my country to the best of my ability throughout this war and a definite place in the future of a new, advanced era.

[*A lot of people will have to do this soon—in fact they are doing it now.*—R. G. OJERS.]

Martin Endows I.A.S. Research

AN ENDOWMENT fund for an aeronautical research laboratory for the Institute of the Aeronautical Sciences was established on June 20th by Glenn L. Martin, aircraft manufacturer. Major Lester D. Gardner, Executive Vice-President of the Institute, in making the announcement, said that Mr. Martin had agreed to give to the fund 25,000 shares of stock of The Glenn L. Martin Co. which has a present value of over $450,000. This stock will be given at the rate of 5,000 shares a year for the next five years. The endowment will bear the name of Mr. Martin's mother, Mrs. Minta Martin.

In establishing this fund, Mr. Martin said: "The recent gift to the Institute of the Aeronautical Sciences of the Long Island home and surrounding estate of the late Daniel Guggenheim by his widow will make available to the aeronautical profession facilities for research and study unexcelled by those of any other scientific society. As aeronautical engineers have provided the basis for the fortunate growth of The Glenn L. Martin Company, I wish to show my appreciation by providing The Minta Martin Aeronautical Endowment Fund, to advance the art and science of aeronautics and to enable the Institute to take the first steps in using this valuable estate. It is my hope that others will also wish to assist the Institute in creating a great aeronautical center with laboratories, archives and libraries for research and study.

"As the effect on pilots of high altitude flying is one of the great problems requiring intensive study, I hope that from the large laboratory building, which the Council of the Institute has named The Minta Martin Aeronautical Laboratory, developments will come which will make flying in the substratosphere more comfortable and safer for our combat pilots. It is also important that after the war passengers be flown at higher altitudes.

"I have given this fund with the confident belief that others who realize as I do the important results that can come from aeronautical research, will also establish similar endowments for this and other purposes so that the Institute of the Aeronautical Sciences may make the fullest use of the great gift of Mrs. Guggenheim."

In accepting this gift Major Gardner said: "This endowment is one of the greatest gifts ever made to a scientific sociey. The Institute is grateful to Mr. Martin, one of its founders, as Past President and an Honorary Fellow, for his generous gift which will permit it to render a service to the nation's war effort."

Glenn L. Martin, President of The Glenn L. Martin Company, which he founded in 1917, has been a manufacturer of airplanes since 1909. In that year he built his first powered aircraft and taught himself to fly. For many years he was one of the best known pilots in the United States.

His first factory was a small abandoned church building near Santa Ana, California. Today the plants of The Glenn L. Martin Company near Baltimore, Maryland, and its subsidiary in the midwest are among the largest in the country. Mr. Martin has built many types of aircraft, notably large bombing planes and the Clipper flying boats used in transoceanic service.

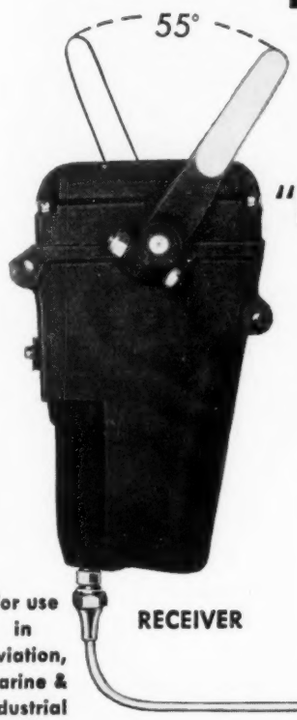
(Continued on page 285)

REMOTE CONTROL

Sperry's

HYDRAULIC "EXACTOR CONTROL"

assures
the smallest movement being
transmitted over long distances
without backlash
Installation simple, quick, economical



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For use in Aviation, Marine & Industrial fields

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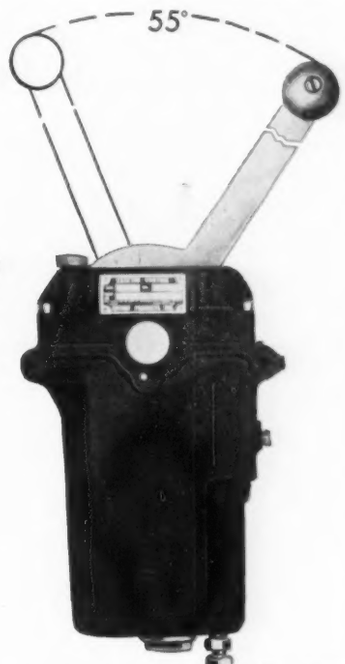

TRANSMITTER

Standard on U. S. Army Air Corps Test Stands

SPERRY PRODUCTS, INC.
Hoboken, N. J.

BLACKOUT...Yet these DIALS can be seen and read

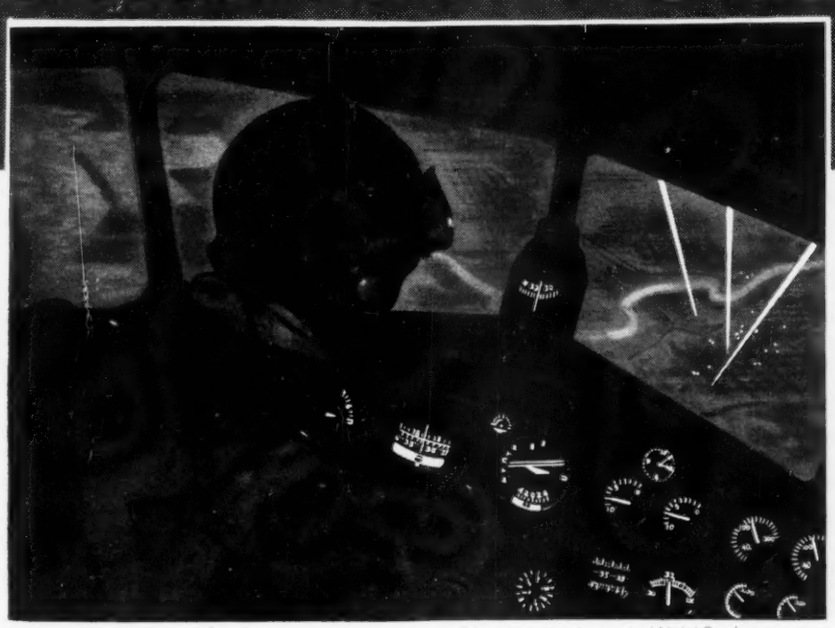

Illustration courtesy International Nickel Co., Inc.

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Glasohms — glass-insulated flexible power resistors and miniature heaters.

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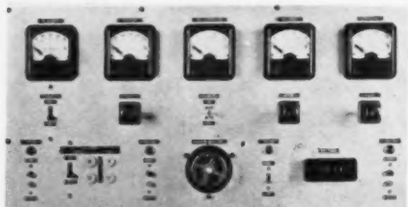
The Month's NEW INSTRUMENTS

In this department we strive to report each month ALL the new devices for measurement, inspection, testing, metering and automatic control—in the form of concise technical descriptions. When writing to manufacturers directly, please mention this department as your source of information. Or write to Information Section, Instruments Publishing Company.

Electrical Testing Panels

New "Standard Panels" provide a speedy and efficient method for production and research testing of all types of electrical equipment. They make possible utmost flexibility of electrical connections so necessary in research and development laboratories. Said to be simple and convenient to operate and built for heavy-duty service, each panel is designed to meet individual requirements. The one shown (one of many in use by a prominent manufacturer) is factory-engineered and built to fit in with user's testing problems. Other installations are of the voltage-distribution type where a great variety of voltages, cycles, and phases are fed to particular test locations from a main central distribution board. Panels can be promptly delivered with high priority rating. No catalogs are available but maker's engineers are prepared to discuss details of individual problems.—*The Standard Electric Time Co., Springfield, Mass.*

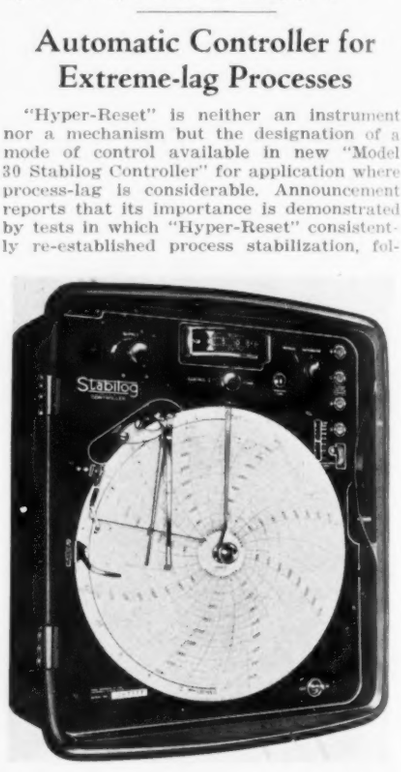


Vibration Test Stand

New "Vibratron" vibration generator for fatigue testing was designed for use in aircraft and industrial plants, is capable of producing vibrations of assorted accelerations and velocities to test products for defects in castings, assemblies, and operation under actual dynamic conditions. It produces vibrations from 0 to 26 times gravity, frequencies from 600 to 3600 cpm, variable while the machine is in operation. Amplitude is variable from 0 to 0.25" total peak to trough, continuously variable with a precision engraved machine dial, resettable to an accuracy of 1%. Vibrating test table is cast aluminum with a multitude of holes to facilitate quick change of products under test. A 6" square table carries up to 10 lbs. at maximum vibration. Machine is approximately 3 ft. long and weighs 65 lbs. with 2" hardwood base equipped with handles and sunken steel mounting inserts in its four corners for anchoring when necessary. Operation is from 105/120 volts, 60 cps on standard models.—*Televiso Products, Inc., 2400 N. Sheffield Blvd., Chicago, Ill.*

Automatic Controller for Extreme-lag Processes

"Hyper-Reset" is neither an instrument nor a mechanism but the designation of a mode of control available in new "Model 30 Stabilog Controller" for application where process-lag is considerable. Announcement reports that its importance is demonstrated by tests in which "Hyper-Reset" consistently re-established process stabilization, following an upset, in one-quarter of the time, and with only one-half the upset effect, as compared with a similar controller having only the usual reset. "Hyper-Reset" reduces effects of a process disturbance by making initial temporary additional corrections, which are proportional to *rates* of change of the measured value caused by the disturbance. The normal reset follows, establishing stabilization. But the several control functions carried out by "Hyper-Reset" are simultaneously and automatically adjusted. No tuning-in is necessary. No more than two process adjustments are required: proportional and "Hyper-Reset." Illustration shows new controller minus door, revealing operating panel at upper right.—*The Foxboro Company, Foxboro, Mass.*



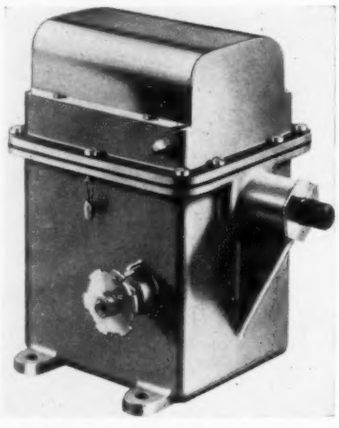
Indicating Type of Remote Speed Control

New "Electric Remote Speed Indicator" is essentially a d-c. voltmeter or milliammeter movement with 4" scale which, however, is graduated in terms of speed setting

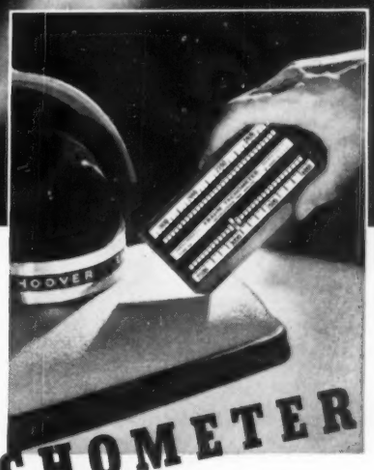
of output shaft of the variable-speed drive which is controlled by a dual push-button station. Calibration is effected by means of a screw which is accessible only when cover of push-button station housing is removed. (Zero-adjustment screw is accessible at all times.) Thus, the "0" to "10" scale is arbitrary—which is an advantage in many applications. Operation is from a flashlight cell (drugstore type will do) through a "potentiometer" resistor actuated by the shifting nut of the variable-speed unit. Current draw being less than a milliampere, cell life is a year or more when permanently connected so that instrument continuously indicates drive setting, whether or not drive is running.—*Reeves Pulley Co., Columbus, Indiana.*

Power Unit for Automatic Control Systems

"Microtrol" is the name of a new unit especially designed for operating butterfly valves, multiple ratio fuel valves; and regulation of dampers in air-conditioning and



drying systems. It comprises a high-torque proportioning control motor with built-in limit switches and potential dividing rheostat. Output shaft is driven by company's shaded-pole induction motor through gear reduction of machine-cut, heat-treated gears. All oil-submerged units have operating mechanism completely submerged in oil and sealed in die-cast case.—*Barber-Colman Co., Rockford, Ill.*



You can measure speeds by TOUCH with a "FRAHM" TACHOMETER

Simply hold the Frahm Tachometer against some stationary part of a motor, turbine, centrifuge or any such machine and almost immediately one of a series of calibrated reeds begins to vibrate, and the corresponding point on the scale shows the speed.

This unique tachometer can be used to measure speed of any single rotating element, large or small, open or totally enclosed, and is equally accurate for measuring vibration frequencies. It has no pointer and no wearing parts and its factory-set calibration cannot be lost through over-speeding or lack of oil. Having no belts, gears, or electrical connections, its use imposes no load on the machine under test. Made in types for hand use and for permanent mounting in ranges from 900 up to 30,000 r.p.m. or v.p.m.

★

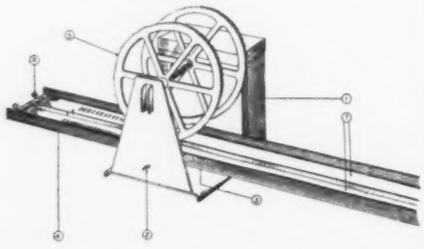
Write for Bulletin 1590-I which describes Frahm Tachometers of both the portable and permanently mounted types.

James G. Biddle Co.

1211-13 ARCH STREET *Electrical and Scientific Instruments* PHILADELPHIA, PA.

Drying Time Recorder

An entirely new and extremely simple method of measuring "set-to-touch" time, "tack-free" time and "dry-hard" or "print-free" time of paints, finishes, etc., is em-



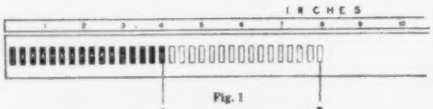


Fig. 1

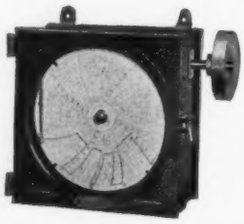
ployed in new Drying Time Recorder. Paint is applied to strips (7) which are fastened by clips (8) to traveling table (4) which is advanced at 30 mm. per hour by engagement of rack (3) and pinion on shaft (2) driven from motor-driven clock mechanism (1). Record is autographed by teeth of floating wheels (5), these teeth picking up the paint, and revealing the bright metal surface of the strip, until "set-to-touch" time (A in lower illustration) after which the teeth no longer remove paint but leave indentations until "tack-free" time (B). When film has so hardened that no impressions are visible when viewed from a 30° angle, this point marks the "dry hard and print free" time. In addition to two-strip model illustrated, larger testers are available with greater numbers of strips and toothed wheels. Standard time period for automatic disconnection is 18 hours, so that tester runs without attention over night.—*Henry A. Gardner Lab., 1500 Rhode Island Ave., Washington, D. C.*

Automatic or Manual Timer

New "Type A-1" Timer has a range of 0.25 second minimum to 15 seconds maximum, set by means of the large calibrated dial in center of panel. The toggle switch

on right-hand side of panel turns timer on and off. The left-hand toggle switch changes timer operation from automatic to manual. When this switch is thrown toward the dial, automatic timer operation is started by pressing the push button momentarily; timer then takes control for the interval setting on dial. When this left-hand switch is thrown away from the dial, timer is cut out and the controlled circuit will then be on as long as push button is held down. Timer is encased in Bakelite box, with Bakelite panel. The two vacuum tubes, relay and other electrical equipment are mounted on an aluminum bracket held to front panel by switch mounting bolts. Thus the contents, with exception of top receptacles, are removable with the panel. Unit is connected for operation by inserting the attachment plug into a 110-volt a-c outlet. Connection of timer to device to be controlled is made through either the two-prong or four-prong receptacle on top. If two-prong receptacle is used, timer acts as a main switch for line voltage. The four-prong receptacle is for the same purpose, except that in addition to timing a circuit on and off, two of the four prongs provide a steady source of 115-volt a.c.—*Abrams Instrument Co., 606 E. Shiawassee St., Lansing, Mich.*

Amthor



Operation Speed Recorder

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12 or 24 hr.

Built for severe service. Users report 10, 12 or more years of trouble-free life. Powerful centrifugal speed-measuring element stays calibrated. Non-spill reservoir pen. Special chart paper. Rugged clock movement. Ideal for analysis of new War Effort jobs.

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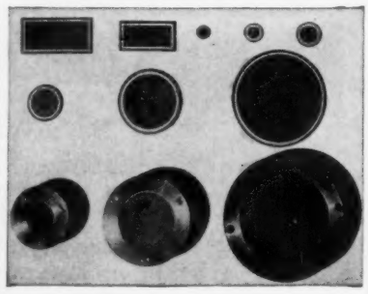

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Unmounted or mounted in various styles of casings.

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Colorimeters Electronic Timers
Reflectometers Photometers
Fluorescence Meters

Fluorophotometer

New "Model C" Fluorophotometer is especially designed to accelerate routine control work in the determination by vitamins and minerals, maintaining established standards of accuracy. It is a complete self-contained unit, incorporating a simple electrical circuit, eliminating the use of amplifier and stabilizer. Features of this new model are a novel slide carriage, accommodating both the blank and sample to be tested and an automatic shutter which shields the sample from the light beam and cuts in the measuring circuit. "Model C" is said to have universal application in fields of fluorometry, colorimetry and turbidimerty using wave-lengths of narrow bands over the entire range of the spectrum from 3000 to 8000 Angstroms. It may be used either with absorption cuvettes or test tubes. Maker's previous models (see *Instruments*, May 1939, page 128) are also available for those who desire the galvanometer as a separate unit so that it may be used for pH measurements, potentiometric-titration and polarographic methods, etc.—*Pfaltz & Bauer, Inc., Empire State Bldg., New York City.*

Vacuum-tube Voltmeter

Accurate measurements throughout entire a-f. range, including u-h. a-f., are said to be simplified by new "Model No. 666" vacuum-tube voltmeter specifically designed for

that purpose. Essentially a peak type of voltmeter, Model 666 has a constant input impedance resistance of 16 megohms. Although designed for 105-130 volt, 60-cycle operation, provision has been made for external battery operation through appropriate terminal connections and a throw-over supply switch. It is said that readings are made quickly and easily. Instrument is equipped with a 4½" rectangular indicator having a movement of 0-200 microamps. Ranges are 0-3-6-30-150 volts. Tubes used are type 6K6GT, 6X5GT, 6H6 and VR105-30. The latter is a voltage regulator, eliminating errors due to line voltage fluctuations.—*Radio City Products Co., 127 W. 26th St., New York City.*

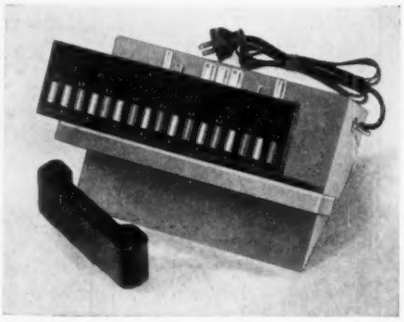
Air Raid Signalling Controllers

Designed to supplant manual methods for sounding "alert" and "all clear" air raid signals, new air-raid alarm unit will automatically control operations of motor sirens,

air or steam sirens, bells, lights, or any standard signal device in compliance with official Civilian Defense standards. Compactly housed in a dust-tight sheet steel case, 14" × 14" × 5", and supplied for either flush or surface mounting positions, controller embodies these features: (1) Indicator lights show whether "alert" or "all clear" signal is in effect. (2) A 3-pole contactor is used in the standard construction and will handle siren loads up to 25 amperes at 110 volts, a-c. non-inductive (3) Toggle switch provides manual operation when desired. (4) Rated for operation from 110 or 220 volts, 25, 50 or 60 cycles. (5) Can be supplied with an automatic throw-over inverter and stand-by battery for insuring operating in event of a-c. power failure.—*Automatic Temperature Control Co., Inc. 64 East Logan Street, Philadelphia, Pa.*

Daylight Lamp for Colorimetry

New "Taylor Midget Dalite Lamp" was designed for use with single Taylor Slide Comparators when determinations must be made at night or in dark places; but it has



been found to be suitable for all routine testing even in daylight. The Comparator base sits on the shelf at an angle of 45° so that, in making readings, one can look directly into the slots in the slide and base. This eliminates handling the outfit, with possible chance of breakage, as only the sample tubes need be handled. Also, in many laboratories and plants, it is almost impossible to obtain a clear daylight background because of walls, trees, etc. The lamp is said to give uniform daylight conditions at all times. It is fitted with a Dalite glass, special bulb, cord and switch and operates on any 110-volt circuit. It can be used with any Taylor pH, Chlorine or Phosphate Comparator.—*W. A. Taylor & Co., 7300 York Road, Baltimore, Md.*

INDEPENDENT SETTING

of plus and minus tolerances

THE outstanding feature is that a selection of tolerance from 0.25% to 10% can be made . . . and the "plus" and "minus" tolerances may be set individually . . . and independently of each other.

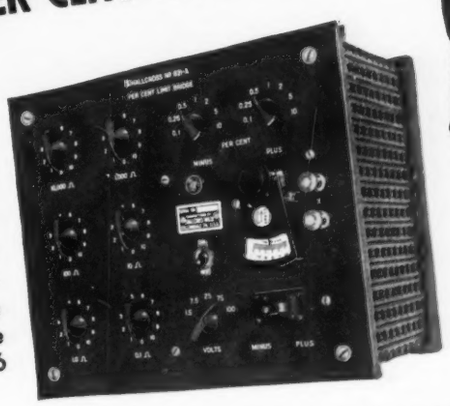
The working standard may consist of 6 decades totaling 1,111,110 ohms . . . in 1-ohm increments. Other ranges . . . to exactly meet individual requirements . . . are available.

By setting the independently operated percentage dials to the "M" position this modern bridge is instantly ready for use as a Wheatstone Bridge (unity ratio) . . . and the actual resistance of the units under test can be readily measured.

This new #621-A Per Cent Limit Bridge is completely self-contained. A standard #6 dry cell furnishes the power for measuring low resistances. For higher resistances, an AC-operated rectifier tube supplies the power.

No. 621-A PER CENT LIMIT BRIDGE

This is a new instrument for rapid and precise inspection of resistors to determine if they are within the specified percentage tolerance. Write for Bulletin D.16



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METERS and CONTROL *for Boiler Room Service . . .*

Boiler Meters Reduce fuel costs, lessen maintenance and outage, lower standby costs, and add capacity. They indicate, record and integrate Steam Flow from the boiler, record Air Flow supplied for combustion and record Flue Gas Temperature.

Bailey Boiler Meter

Multi-Pointer Gages for indicating drafts, pressures, differentials are available with any number of pointers from one to twelve. They are actuated by sturdy yet sensitive diaphragm units.

Multi-Pointer Gage

Flow Meters. For indicating, recording and integrating the flow of steam, feed water, compressed air and other fluids.

Coal Meter

Granular Material Meters For accurately measuring the flow of coal or other granular materials in gravity chutes from overhead bunkers. The total quantity of granular material is shown on a large illuminated counter which may be easily read at a distance of 50 feet.

Control Systems Make possible the everyday operation of equipment for steam generation and utilization at test efficiencies. They are applied to the control of combustion, feed water, superheat, desuperheat and other factors.

Complete Information on any of the above Bailey products will be gladly furnished upon request.

G-14

BAILEY METER • COMPANY •

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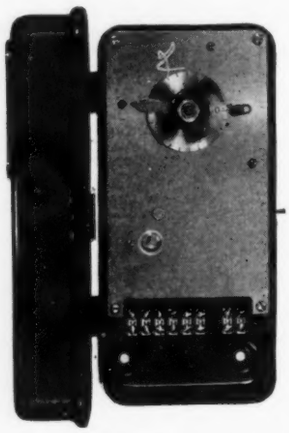
BAILEY METER COMPANY LTD., MONTREAL

Instantaneous Reset Timer

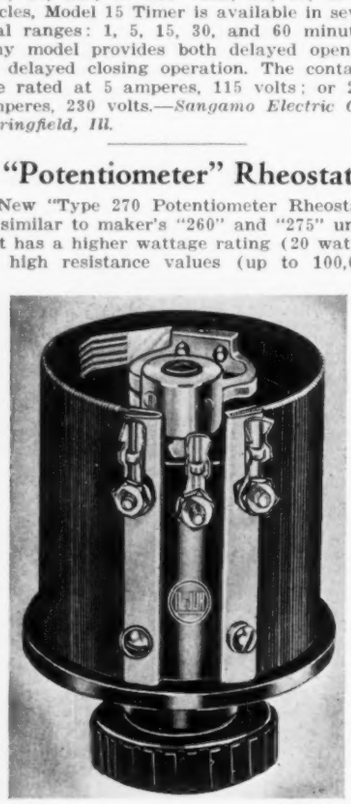
Providing a delayed opening or a delayed closing circuit, new "Model 15" Instantaneous Reset Timer is started and reset electrically. Dial indicates time setting and



elapsed portion of time interval during operation. Controlled automatically by connecting it to a circuit controlled by some other device, timer may also be operated manually by connecting it to operate from a switch or push button. For operation on a.c., 24, 115, or 230 volts, 25, 50, or 60 cycles, Model 15 Timer is available in seven dial ranges: 1, 5, 15, 30, and 60 minutes. Any model provides both delayed opening or delayed closing operation. The contacts are rated at 5 amperes, 115 volts; or 2½ amperes, 230 volts.—*Sangamo Electric Co., Springfield, Ill.*

"Potentiometer" Rheostat

New "Type 270 Potentiometer Rheostat" is similar to maker's "260" and "275" units but has a higher wattage rating (20 watts) at high resistance values (up to 100,000



ohms) made possible through careful design: large surface for heat-dissipation and other features. On both low- and high-resistance units, tendency of rotating arm to jump from one wire to the next has been eliminated by use of DeJur self-aligning inside wiper with its five contact fingers "maintaining perfect alignment with each individual turn of resistance wire." This minimizes wear on contacting surfaces over entire range of resistance winding. On low-resistance rheostats, contact pressure is adjusted to provide lowest contact resistance with minimum of wear. Rotation angle is approx. 327°; no off position. Net weight 8 oz.—*DeJur-Amsco Corp., Shelton, Conn.*

TEST MAGNETIC PROPERTIES OF YOUR STEELS

THE ONLY SINGLE BUTTON ELECTRICAL RETURN FLUXMETER

SIMPLEST AND MOST EFFICIENT

Bulletin 504

THREE DIFFERENT STYLES

Portable Standard with single electrical zero return.

Switchboard Type with above zero feature located on flexible lead for bench operation.

Two Button Pointer Shift in place of our patented standard zero return at a lesser cost.

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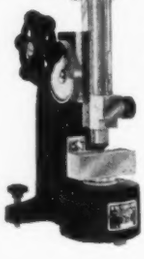

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9025 Van Wyck Ave., Jamaica, N. Y.

Buffer Set for pH Tests

New "Cargille Buffer Set No. 1" permits making pH tests simply. Solutions of known pH are made by dissolving the tablets in this set. These are applied to "Hydrion Wide-Range pH Test Paper" (*Instruments*, July 1938, page 175) to bring out on the paper the color for any half unit from pH 3 to pH 11. The colors are used for reference to judge the pH of the sample being tested; comparisons made with these reference colors are more accurate than those made with color charts. Readings can be made to one-half pH unit. Set is designed for control tests in the plant by unskilled workmen; also for quick, preliminary tests in laboratories where more elaborate pH apparatus is available.—*R. P. Cargille, 118 Liberty St., New York City.*

Heavy-duty Thermostat

New "TA42" high-capacity thermostat, for use wherever two-wire (Series 40) or three-wire (Series 60) line voltage control is required, is an electrical version of the horizontal design which M-H pioneered in pneumatic control. This principle is said to afford maximum air circulation about the element and insures against possible harmful effects of electrical contact heat. Motion of vapor-filled bellows is transmitted to the "QS611 Con-Tac-Tor Snapswitch." This switch is non-magnetic in operation, unaffected by vibration or "contact bounce," fully enclosed to protect it from dirt, dust and grime—a feature assuring long life to the special silver contacts. Some other standard features: (1) Removable adjustment knob also locks cover and thus prevents unauthorized tampering. (2) Bakelite base is both an efectrical and a thermal insulator. (3) "Dead front" eliminates shocks and short circuits. The TA42 is readily applicable to motor-driver unit heaters, water circulators, coal blowers, motorized valves and motorized dampers. It can also be used with a magnetic starter on large or polyphase motors.—*Minneapolis-Honeywell Regulator Co., Minneapolis, Minnesota.*

Inside Diameter Gage for Shallow Holes and Recesses

New "Model 167 P-75" is a single-purpose production gage for checking a shallow recess 6.80" diameter. The indicator is set back away from contacts to clear obstruc-

tions on the machine. Motion of the sensitive contact is carried back to the indicator through a spring hinge, thus eliminating all lost motion, which would be present if a bearing were used. This construction also eliminates friction. The indicator is graduated in tenths of thousandths. Its range is 0.025" and its dial is graduated 0-4-0.—*Federal Products Corp., 1144 Eddy St., Providence, R. I.*

AMPLE POWER

Directed by a

PILOT

That's the principle of the NULL BALANCE METHOD employed in the

COCHRANE

Friction-Free

FLOW METER

THE null or zero balance method consists in balancing the unknown quantity by adjusting a known quantity of the same kind, a highly sensitive detector being used to determine the point of balance.

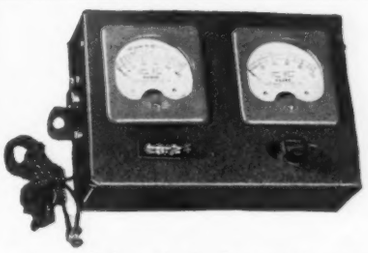
A friction-free transmitter serves as the pilot for an external motor drive which restores the electrical bridge to balance and operates pen, indicator and integrator with high and equal power throughout the entire scale.

NOTE: A bridge circuit alone is *not* a null method meter. A galvanometer is required to detect unbalance and an external source of power is needed to restore balance. These are found ONLY in the Cochrane Electric Flow Meter.

Send for 56-page "Flow Meters by Cochrane"

COCHRANE CORP., 3120 N. 17th ST., PHILADELPHIA, PA.

Cochrane
FLOW METERS



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VACUUM GAUGES
(PIRANI TYPE)

Shown at left is meter box of our model No. 6 gauge.

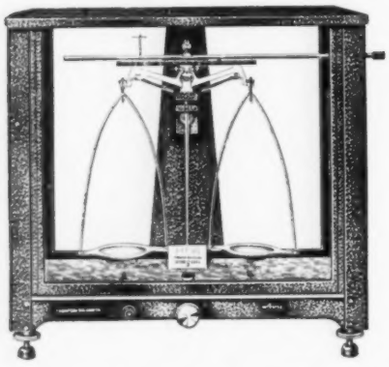
This gauge successfully used by many of America's foremost manufacturers.

Send for circular on our new low priced D.C. operated gauge.

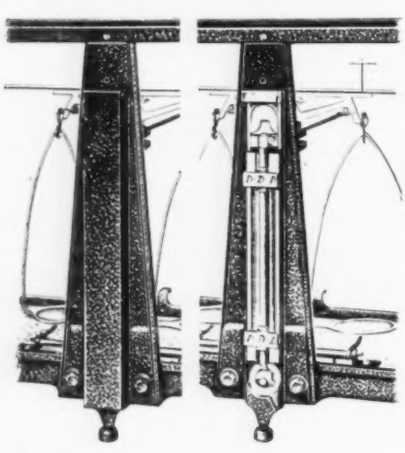
CONTINENTAL ELECTRIC CO.
GENEVA, ILLINOIS

Analytical Balance

"Analytical Balance Style No. 132" is a six-inch beam instrument sensitive to 1/20 mg. which utilizes a radically new principle patented Feb. 3, 1942: operating mechanism



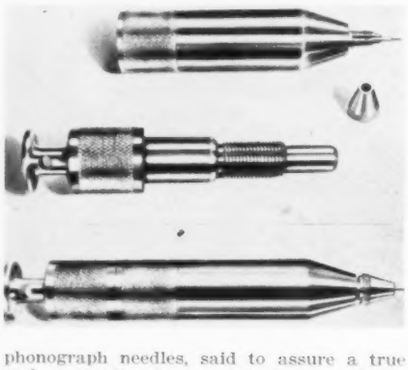
for releasing the beam is mounted *outside* the case, leaving the space between pans clear except for index and pointer. A rigid metal panel divides the rear glass centrally. It has a V groove cut into its outer wall to



form two sides of a three-line bearing at each end of round rod that lowers beam; third side independently adjustable at each end of rod to make a close fit regardless of rod diameter, and to take up wear after long use. This mechanism is covered by a channel piece which can be instantly removed without tools so that lubrication, adjustment and other servicing can be accomplished in minutes, it is said, whereas "hours are required with the old type of central-column balance." Beam is aluminum, 50 divisions on each side; white graduations on black ground; each division indicating 1/10 mg. with a 5-mg. rider. Pointer scale is white with red graduations. Bows are 4¼" wide, 7¼" high. Push-button release for pans. Case is aluminum with durable black finish. Inside floor material hard and smooth like glass and with a mottled blue surface. Counterpoised door; level and leveling screws. Agate edges and bearings or steel edges and agate bearings. Dimension 15½" × 7½" × 15". Net weight 14 lbs. *—Thompson Balance Co., 808 20th Street, Denver, Colo.*

Precision Plumb Bob

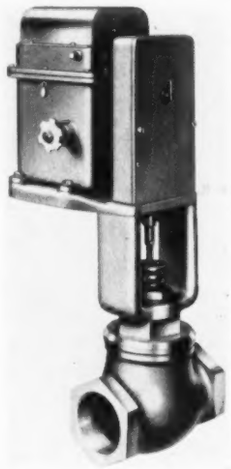
Particularly adaptable to armament and jig installations, as well as other operations where precision aligning is necessary, new Precision Plumb Bob makes a novel use of



phonograph needles, said to assure a true and constantly sharp point at a practically nil replacement cost. The needle is held by a watchmaker's pin chuck at the indicating end. The hole for the suspension wire is held to "exact size" and is "absolutely centered" with the indicating point. Upper part is threaded into lower part. Three bearing surfaces between these parts hold them concentric so that by simply rotating one part upon the other it is possible to raise or lower the indicating point (phonograph needle) over ½" without losing concentricity. This adjustment feature is said to be particularly important in the aligning of gunsights and other armament installations. *Aero Tool Co. 231 West Olive Ave., Burbank, Calif.*

Motorized Valve

"Microvalve" is the name of a new motorized valve designed for the control of steam, water, oil or gas in air conditioning systems, dryers, and industrial process work



where close regulation is required. It is a motor-operated valve with proportioning type operator. Valve operator consists of a "Microtrol" with the addition of an eccentric cam that operates valve plunger. Single-seat V-ported, double-seat V-ported, and double-seat 3-way valve bodies are available.—*Barber-Colman Co., Rockford, Ill.*

Gage for Diameter and Roundness of Spinning Rings

New "Model 247 B-69" is a production gage for checking the concentricity of spinning rings from 1" in diameter. It can be modified to suit larger or smaller diameters. After the two hardened steel-faced guides are set in correct position the workpiece is rotated in contact with the guides and both diameter and roundness are checked simultaneously. Note that the indicator does not make direct contact with the ring, but through floating pantograph unit, which increases the sensitivity of the gage, and protects the indicator spindle. The indicator is "Model C81," graduated in thousandths; dial 0-5-0; range 0.250".—*Federal Products Corp., 1144 Eddy St., Providence, R. I.*

To keep production wheels humming by co-operating with the demands of Uncle Sam and industry.

To give as quick a delivery as possible.

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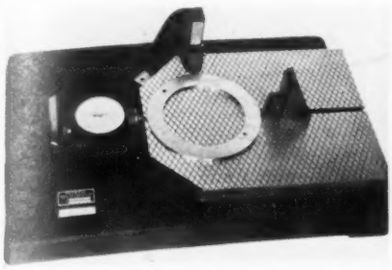
INDUSTRIAL LABORATORY, DIAL AND RECORDING THERMOMETERS

Diameter and Roundness Gage

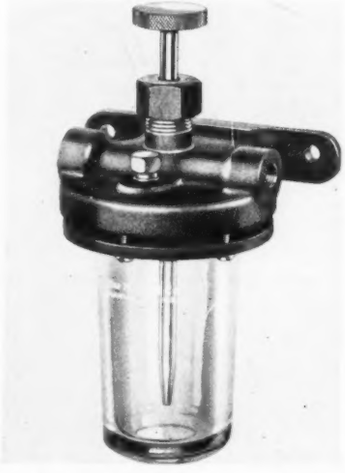
New "Model 247 B-63" gage obviously inspects work for diameter and roundness. It is, however, universal and is readily adapted to inspection of work of various diam-



eters and thicknesses. It can be easily modified to inspect even smaller or larger work than this particular gage is designed for. The indicator is a "Federal Super-sensitive" type, graduated in ten-thousandths, provided with a fine adjustment longitudinally. The platen is ground and lapped. Both stops, as well as the indicator, are adjustable both horizontally and vertically. Minimum capacity of gage is 6", maximum 12"; minimum thickness ¼", maximum 2". Indicator range is 0.010" width 0-5-0 dial. *Federal Products Corp., 1144 Eddy St., Providence, R. I.*

Sight Feed Bubbler

New Sight Feed Bubbler is for continuous operation of tank liquid level gages, but has wider application where a sight indicator is required, to purge lines (giving visible indication of gas flow), to note presence of harmful or undesirable gases, and to use in conjunction with flow meters for the



measurement of corrosive materials, thereby eliminating the problem of satisfactory sealing fluids. In operation, bubbler bowl is filled with liquid. Rate of bubbling is adjusted by means of a stainless steel needle valve at top of unit. All air or gas passes needle valve before entering bubbler tube inside bubbler bowl. Bubbler with bowl of molded Pyrex glass (2¼" diam., 3½" deep) is good for line pressures up to 30 lbs.; of plastic, for pressures up to 100 lbs. Brass or semi-steel construction. Two types: (1) ring type (illustrated) has bubbler bowl fastened to body by means of a packing ring held in position by 6 screws. (2) Strap type has bubbler bowl fastened in position by means of a clamping screw at bottom of swinging strap. Ring type has been designed for greatest unobstructed vision of the bubbler bowl; strap type allows convenient and quick removal of bubbler bowl.—*The Meriam Co., 1955 W. 112th St., Cleveland, Ohio.*

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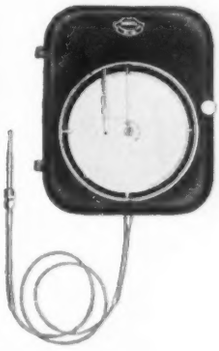
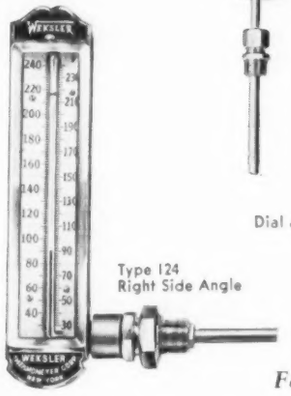
Weksler Thermometers are scientific, precision instruments. Their rugged construction and lasting accuracy will merit your full confidence. Red Reading Mercury tubes are standard in all V shaped bronze case industrial thermometers. Indicating and recording thermometers are furnished mercury, vapor or gas actuated. Dial indicating thermometers available in 3½, 4, 5, and 6 inch sizes. Recording thermometers furnished with 6, 10 or 12 inch chart sizes. There is a Weksler precision thermometer for every industrial need.

"V" Shaped Bronze Case Industrial

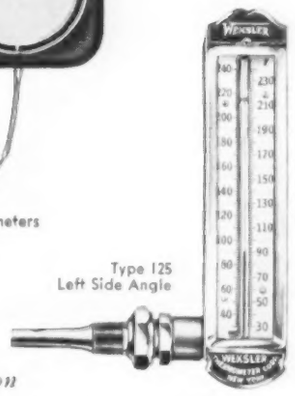
Thermometers and Hydrometers



Dial and Recording Thermometers



Type 124 Right Side Angle



Type 125 Left Side Angle

For information on

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For others, send for Catalog No. 115.

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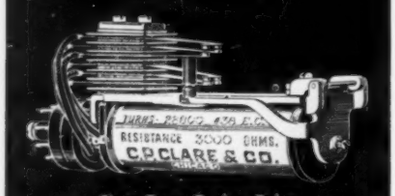
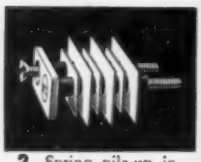


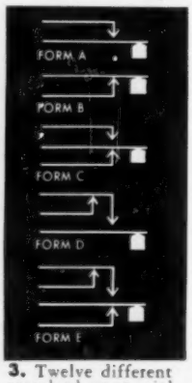
Clare Type C d. c. Relay

■ **This rugged multiple-contact relay permits innumerable contact arrangements. Permits designing to small size, with a lesser number of relays; and facilitates maintenance. Adapted for use in electronic control devices and for sequence control and interlocking operations. Ideal where unusual arrangements of relay control are desired. Here are the reasons why:**

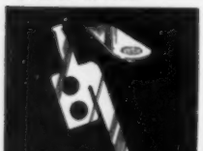
1. Contact springs employing any of the forms illustrated can be furnished.



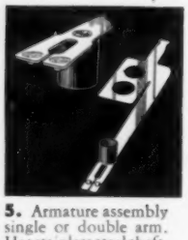
2. Spring pile-up insulators of heat treated Bakelite which permit punching without cracks, have minimum cold flow and low moisture absorption content. Assembly locked together under hydraulic pressure. Withstands heavy breakdown tests.



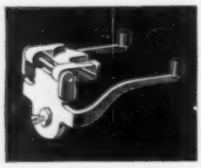
3. Twelve different standard or special types and sizes of contacts can be furnished. Contacts are overall-welded to nickel silver springs. Sizes range from .062" silver, rated one ampere, 50 watts, to .1875" tungsten, rated four amperes, 500 watts.



4. Spring bushing insulators are Bakelite rod made by a patent process. Strong, hard, long wearing. Essential where heavy contact pressures are employed, where vibration exists, or heavy duty service is desired.



5. Armature assembly single or double arm. Has stainless steel shaft, operating in a marine brass yoke. Heel piece, coil core and armature are magnetic metal carefully annealed. Designed for d.c. service.



6. As illustrated, relay has octal base plug mounting for easy service and replacement. Other mountings, and Bakelite or metal cover, can be supplied.

• • •

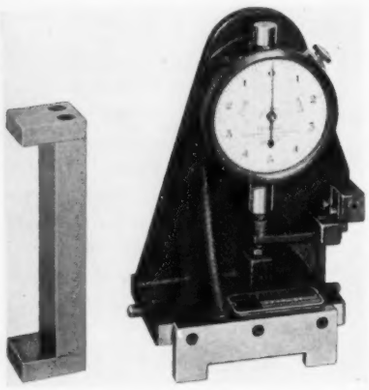
This relay is an example of Clare "custom-built" design and construction. Clare engineers can "custom build" a relay to meet your specific requirements—one that will reduce your overall relay cost and simplify your design problem. Write for catalog and data book. C. P. Clare and Co., 4719 West Sunnyside Avenue, Chicago.

CLARE RELAYS

"CUSTOM-BUILT" Multiple Contact Relays for Electrical, Electronic and Industrial Use

Crankshaft Bearing Face Distance Gage

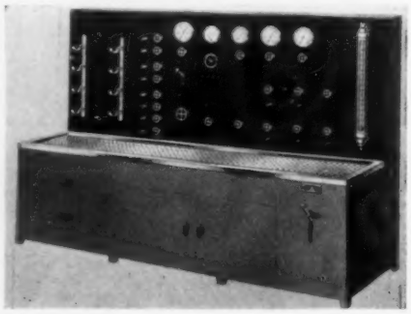
New "Model 294 P-26" gage is for inspecting the distance between faces of crankshaft bearings. Master check is shown at the left of gage. Note that the sensitive



contact point at the right of the base is mounted on a triangular piece which is supported on flat springs, allowing it to transfer the motion to the indicator without friction or lost motion. The latter can be controlled by the screw and check nut below the indicator point.—*Federal Products Corp., 1144 Eddy St., Providence, R. I.*

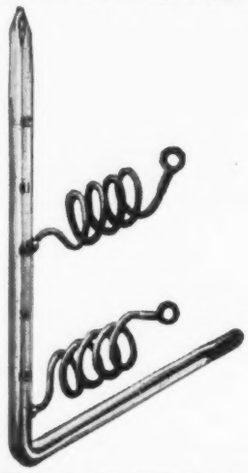
Pressure-test Stands

Development of four new types of test stands was based on a survey made among leading maintenance bases of airlines, and independent service bases. Basic unit is an elaborate and unusually complete stand for hydraulic cylinders, control valves, pumps, relief valves and component equipment. Pressures up to 16,000 lbs./in.^{2} are available on this unit. The other three units are especially designed for fuel pump, hydraulic oil pump and vacuum pump testing and are complete testing units within themselves. Test stand for hydraulic systems has a welded steel angle iron sub-frame, with ½" plywood or sheet metal sides, front and back. Entire bench is covered with perforated metal sheet which forms a convenient sink over which to work. All gages and valves are on a vertical back panel, made from ⅜" Masonite. Protecting each low-pressure gage is a relief valve set at a maximum working pressure of the gage. Under work-bench-sink is the 10 h-p. motor-driven pump which delivers up to 10 g.p.m. at pressures up to 2,000 lbs./in.^{2}. To obtain higher surge pressures, a multiplier cylinder is used which will provide up to 16,000 lbs./in.^{2}. Variable speed drive between motor and pump gives an infinitely variable flow output to the pump. A 25-gallon reservoir for the hydraulic fluid is provided, and a relief valve set at 2,000 lbs. is attached to the pressure accumulator. Wire mesh intake screen is provided on reservoir, also special filters and oil strainers. Heat exchanger with thermocouples gives exact temperatures of the in-going



For Extremely Close Temperature Control

Visual-Stats



● Sensitivity of a hundredth of a degree is easily attainable. ● Top of mercury column visible at control point (where most important) because electrodes terminate at back of tube. No encircling metal bands! ● Available in angle form (illustrated) or conventional straight form. ● Send for brief, attractive bulletin.

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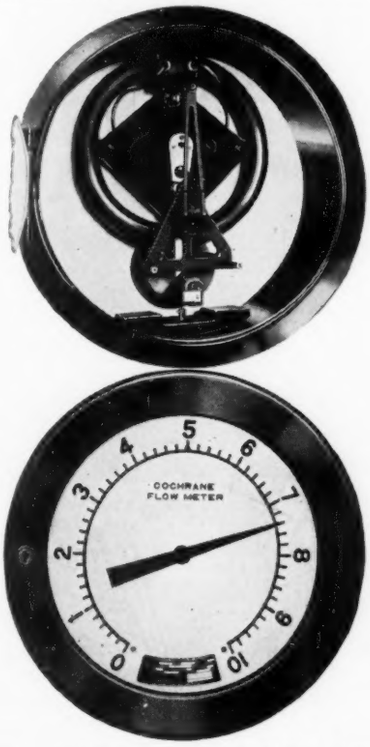
out-coming oil. By varying amount of ...ing water through heat exchanger, any ...ired temperature of oil can be main...ined. Thermocouples are also provided on ... of the twelve flexible hose connections, ... indicating temperatures in and out of ...ipment under test. Chief purpose of ...ilding separate fuel pump, hydraulic oil ...mp, vacuum pump and hydraulic system ...st stands is to make possible the installa...ion of the most needed units in a mainte...ance base, to which can later be added the ...ditional testing units. — *Burklyn Corp., Glendale Ave. & Seneca St., Los Angeles, Calif.*

High-pressure Flow Meter

For high-pressure process operations in the neighborhood of 5000 lbs./in.^{2}, it is said that accuracy, freedom from maintenance, and complete safety in flow measurement



are secured by a special adaptation of the ring balance (tilting U-tube) which has no float, stuffing box, or pressure-tight bearing; being entirely closed and without internal working parts. The mercury-sealed manometer is a stainless steel ring 15" in diameter, balanced on knife edges at its geometric center. Partition at top of ring is formed of a solid stainless steel block suitably drilled for the pressure connections. Nickel tubing connects top of ring to center of rotation where they join the free (inboard) ends of twin 6" nickel torsion tubes. Outboard ends of torsion tubes are anchored and to these the pressure lines from the primary elements are connected. By this design the ring tilts 10° for the full differential range measurement, which may be between 4" and 9" of mercury depending on the cam weight supplied. The cam extracts the square root relationship so as to express the flow directly in uniform increments on the 36" long indicating scale which may also be combined with an integrator and/or 12" round-chart recorder. Construction is said to be exceptionally rugged and to combine every desirable detail such as ball bearing cam strap sheave, integral plumb bob and alignment scale, lens type metal gaskets, mid-scale calibrating pin so as to afford maximum dependability and operating convenience. These meters are tested under 7500 lbs./in.^{2}.— *Cochrane Corp., 17th St. & Allegheny, Philadelphia, Pa.*

★

Cut-Away View of Ohmite Rheostat Shows How Smooth, Close Control Is Permanently Built-in

The wire is wound on a solid porcelain core, locked in place and insulated by Ohmite vitreous enamel. Nothing to shrink, shift or deteriorate. Self-lubricating metal-graphite contact, with universal mounting, insures perfect contact, prevents wear on the wire. High-strength ceramic hub insulates shaft and bushing. Many other features for long, trouble-free service.

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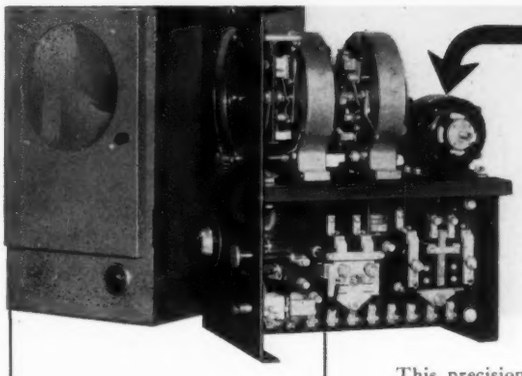

PRECISION POWER for Precision Timing

This precision welder control is manufactured by the Square D Company, Milwaukee, Wis. It makes and breaks the power circuit synchronously to control the welding operation in the fabrication of stainless steel, aluminum, brass, and copper in many small parts. Accurate power for this timer is supplied by a Bodine synchronous motor.

This precision timer is used to control the welding current in an automatic spot welder. It turns the current on and off at the proper time and utilizes only the correct fraction of the alternating current cycle. It is highly important that every part of the equipment, including the driving motor, be absolutely reliable and accurate.

A Bodine motor was chosen for this precise job because these motors can be depended upon to provide accurate performance over long periods of time. Many instrument manufacturers have standardized on Bodine motors for this reason. Bodine Electric Company, 2244 W. Ohio Street, Chicago, Illinois.

BODINE

BODINE FRACTIONAL HORSEPOWER MOTORS

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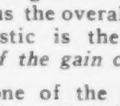
★ Ever stop to think that the input attenuator of an oscillograph may be causing distortion due to frequency discrimination before the signal is applied to the amplifiers? We at DuMont couldn't justify the use of a wide-band deflection amplifier if the input attenuator caused pre-distortion of the signal.

So, by including a cathode-loaded input stage in the Type 208, and placing the variable attenuator in the low-impedance cathode circuit, we eliminated the effects of changes in distributed capacitance influenced by the setting of the potentiometer rotor. Thus the overall transmission characteristic is the same *at all settings of the gain control.*

This is one of the many reasons why the Type 208 is first choice for a general-purpose cathode-ray oscillograph.



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Gravitometer for Small Volumes

An entirely new method of measuring specific gravity, devised by Dr. David Davidson of Brooklyn College, Brooklyn, N. Y., enables determinations to the third decimal place on samples with volumes as small as 0.3 ml., between Sp. Gr. 0.60 and 2.00.

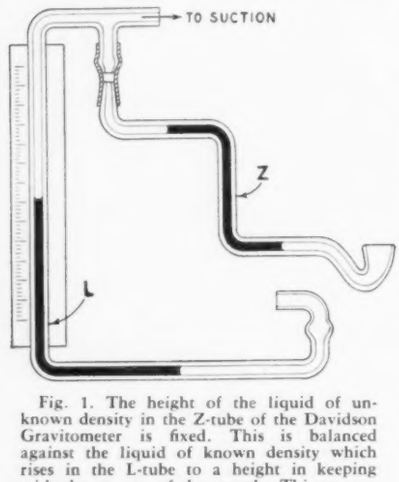

Fig. 1. The height of the liquid of unknown density in the Z-tube of the Davidson Gravitometer is fixed. This is balanced against the liquid of known density which rises in the L-tube to a height in keeping with the sp. gr. of the sample. This sp. gr. is read directly from the scale.

Principle: The fact that air pressure forces water to rise about 13.6 times as high as mercury in a barometer is so elementary that it need not be stated for *Instruments* readers except as a reminder; it is the effect of air pressure upon liquids of different specific gravities which has been ingeniously employed by Dr. Davidson by the combination of two capillary manometers shown in Fig. 1. One is a Z-shaped tube with upper and lower horizontal arms, and the other is an L-shaped tube. One limb of each of these manometers is open to the atmosphere. In use, a liquid of known specific gravity such as certified ethylbenzene or certified carbon tetrachloride is placed in the L-shaped tube and the sample, which may be as small in volume as 0.3 ml., is placed in the Z-tube. The pressure in the part of the system which is common to both manometers is reduced by means of a simple pump with the result that the liquid

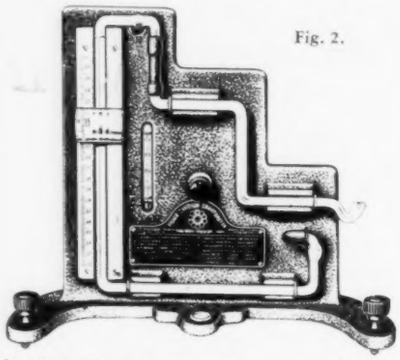

Fig. 2.

levels in the two manometers are raised by the atmospheric pressure. A fixed head of the liquid being measured is thus balanced against a liquid of known density. The head of the latter in the L-tube varies in direct proportion to the density of the unknown sample in the Z-tube.

Commercial embodiment of this new method is the Fisher-Davidson gravitometer, Fig. 2. The suction pump for raising the liquid levels consists of a length of rubber tubing inserted between metal rollers and connected at one end to the common junction of the two manometers. It is operated by a knob on the front of the instrument, whereby the tubing is drawn between

In ordinary fuses, crystallization and cracking are a common cause of fuse failure, due to repeated expansion and contraction of fuse element. LITTELFUSE Non-Crystallizing Fuse Elements, *efficiently* meet this condition with as much as *six times* the service life of others.

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For delicate instruments and other equipment, microammeters, milliammeters, wattmeters, voltmeters, galvanometers, radio, production test equipment, signal meters, thermocouples, battery sets, etc., 1/200 amp. up. Hi-volt 1000, 5000, and 10,000 ranges, 1/16 amp., up. All types of Littelfuses for aircraft, radio, auto, etc., and mountings. Send for complete catalog.

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Described in Bulletin 270 which also describes *Rubicon* High Precision Type B Laboratory Potentiometer.

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...ers and the pressure (in the part of the ...em common to the two manometers) ma... varied at will. A cursor with index lin... agnifier and vernier can be raised or low... on the graduated scale. The gradua... are based upon the use of certified eth... nzene as the standard. For liquids of hig... specific gravity than 2.00, ethylben... zene is replaced by certified carbon tetra... chloride and a conversion factor is applied. For work with most organic liquids, a capillary of 1.9 mm. bore is employed. Because liquids of high viscosity, such as oils, would attain equilibrium too slowly in this tube, a capillary of 4.0 mm. bore is also required. It also serves for measuring water and aqueous solutions. With these two tubes, a full range of organics can be covered. A third Z-tube, of 0.8 mm. bore, is for liquids of extremely low viscosity.—*Fisher Scientific Co. 711 Forbes St., Pittsburgh, Pa.*

Feeder Voltage Regulator—Air-cooled Indoor Model

Especially designed for feeder circuits where exacting voltage regulation requirements must be met and liquid cooling is undesirable, new low-cost "Type SA" air-cooled voltage regulator for indoor use is intended for single-phase feeders, 2400 volts, 0 to 300 amperes, and 4800 volts, 25 to 150 amperes. Single-phase units can be used in banks on polyphase circuits two units in open delta on 2400- or 4800-volt 3-wire cir-

cuits or three 2400-volt units on 4160-volt 4-wire circuits. All ratings have self-contained power for motor and other control functions. No liquid cooling is required and winding insulation is flame-resisting. For low maintenance and continuity of service, a new design of voltage-regulating relay eliminates usual assembly of delicate pivots, pins and springs. Separate transformers prevent operation of the motor from affecting the relay. Air cooling is by natural convection. Outside air enters through two openings on each side of regulator, passes upwards through ducts and is discharged at top. Although operating on the transformer principle, general construction resembles an induction motor: unit has a stator and rotor, with primary or shunt winding wound on rotor and secondary or series winding on stator. Regulation is accomplished by turning rotor to change relation of rotor winding to stator winding. Voltage induced in series winding, in series with the line, increases or decreases line voltage depending on position of rotor. Change of voltage is smooth and gradual in either direction as the circuit is not opened at any point.—*Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.*

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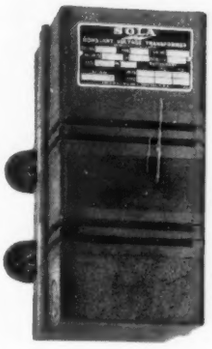

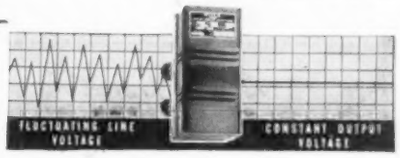

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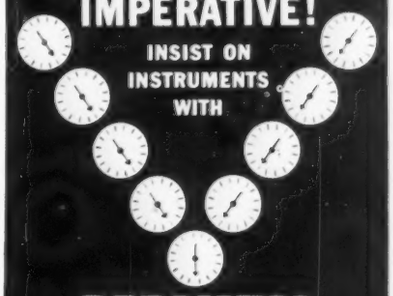

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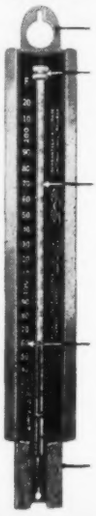
For speeding the production testing of capacitors and resistors, or their incoming inspection for conformance with tolerance specifications, new "Model LB-1" high-speed limit bridge is said to be characterized by

"negligible setup time, great flexibility, wide range, accuracy within ±1% of standard, high speed and extreme ruggedness, together with moderate cost." For checking capacitors, when used in conjunction with maker's "DK-2A Decade Capacitor," bridge has a range of 0.001 to 1.1 mfd. in 0.001 mfd. steps. However, bridge can be used with decades of other ranges, or with independent capacitance standards. Accuracy of ±1% is based on the use of a standard that comes within that tolerance. For checking resistors, Model LB-2 is supplied with a resistance standard having a range of 1000 ohms to 1.11 megohms. Other resistance standards may be used if desired. Different models are required for capacitance and resistance measurements. For production testing, all that is necessary is to set the instrument's high-low dials for the desired plus-minus limits. The closing of the corresponding cathode-ray null indicator warns when limits are exceeded. With properly trained operators, speeds up to 1000 capacitors or resistors per hour are said to be entirely feasible. Instrument is furnished ready to operate on the usual 105-130-volt 50-60 cycle a.c. High-speed test fixture, incorporating test switch, is available if desired. — *Industrial Instruments, Inc., 156 Culver Ave., Jersey City, N. J*

Mercurial Type High-amplification Control Unit

New "Mercurystat" control element, applicable in automatic-control systems where a 0.015" movement and 0.05 watt of power are available for actuation, consists essentially of a flexible bellows and a mercury column which closes a series of forty contacts. Bellows can be actuated mechanically, as by a centrifugal speed governor; or by an electromagnetic primary element responding to current or voltage. In the latter case a change of 0.05 watt suffices to raise mercury column past all forty contacts. Change in power controlled (in arrangement shown in photograph) being 5000 watts, amplification factor is 100,000. Hydrogen sealing of contacts and low potential difference between adjacent contacts permit handling relatively large currents: in a test on a 220-volt d-c. circuit the current was varied five million times from 12 to 30 amps. and the contacts showed no sign of wear. Device is said to be insensitive to changes in temperature or pressure.—*Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.*

ACCURATE V-CASE TYPE THERMOMETERS



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I.A.S. Endowed *(Continued from page 270)*

He received The Collier Trophy in 1932 for the design and construction of the B-10, which was then the fastest bombing plane of its time. The Daniel Guggenheim Medal conferred annually by representatives of the I.A.S., the S.A.E. and the A.S.M.E. in recognition of notable achievement in the advance of aeronautics, was awarded to him in 1940 "for contributions to aeronautical development and the production of many types of aircraft of high performance."

The Institute of the Aeronautical Sciences was organized in 1932 "to advance the art and science of aeronautics." At present it has headquarters in Rockefeller Center, New York, 47 branches and sections throughout the country, and a membership of more than 4,800.

The Aeronautical Archives of the Institute is the custodian of the W. A. M. Burden Library of about 12,000 aeronautical books, magazines, pamphlets, photographs, reports and clippings, forming probably the most complete privately owned aeronautical library in the world, and in addition operates an aeronautical lending library of 6,000 books endowed by Paul Kollsman with $65,000. The Archives is also a repository for models of airplanes, books, trophies, photographs, prints, medallions and clippings presented to the Institute.

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Either 6 × 30 or 7 × 50, made by Bausch & Lomb or Zeiss. The 6 × 30 means six-power magnification and a front lens 30 millimeters (about an inch and a fifth) across. The 7 × 50 means seven-power and 50 millimeters (about two inches) across.

Most binoculars have the power and millimeter measurement marked on them. If yours do not, one quick, simple way to ascertain both is to measure the diameter of the front lens, inside frame; then hold binoculars at arm's-length toward a light or window and measure the "exit pupil" or round glimmer of light that appears on the eye lens. Divide the front lens measurement by the measurement of "exit pupil." The result is the power of the binoculars.

Binoculars of less than six power have proved of small value at sea because they do not magnify objects sufficiently. High-powered binoculars with front lenses less than 3 millimeters wide also are of little use, as they shut out too much of the light necessary to good vision, especially at night or in hazy weather. For much the same reasons, toys, lorgnettes, opera glasses, small prismatic-type binoculars and binoculars of the Galilean type (which have no prisms to help focus images correctly) are useless for naval purposes.

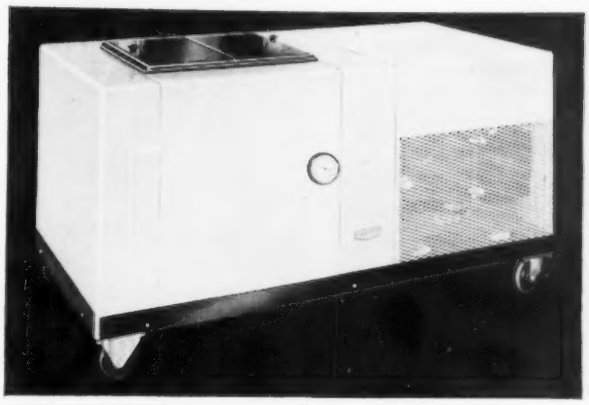
The Navy also specifies two standard and widely-used makes of glasses because of the difficulty of obtaining replacement parts and trained personnel to keep a variety of glasses in perfect condition. It may be able to make mechanical repairs to binoculars not in good shape now, but cannot undertake to replace broken or cracked lenses or center hinges.

Persons whose binoculars meet requirements and who wish to lend them to the Navy are requested to tag them with the owner's name and address, pack them carefully and ship to: THE NAVAL OBSERVATORY, WASHINGTON, D. C.

If your binoculars are not in good working order, or if they are approximately but not exactly up to Navy specifications, do not ship them. Instead, write a letter to the Naval Observatory, giving *manufacture, type, power and objective opening* (front lens measurement) of binoculars and stating what repairs, if any, are needed to put them in good condition. Such binoculars will be called for if and when needed.

As the Navy is not authorized to accept gifts or free loans, all binoculars it accepts will be "purchased" for $1.00 each. If still in use at the end of the war, they will be returned to the owners annd the $1.00 will constitute a rental and depreciation fee.

All binoculars accepted are engraved with the donor's name and a special serial number to identify them. They are then issued immediately to naval vessels and the commanding officers are requested to notify the donors of the names of the ships aboard which their binoculars are "serving in the Navy."



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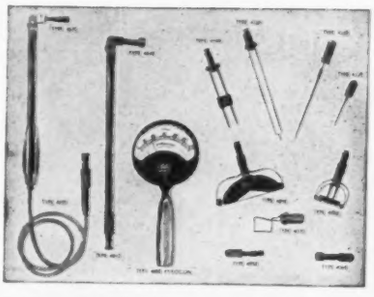

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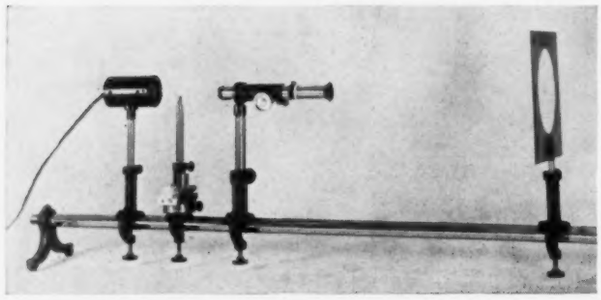

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Ordnance Production Gaging

(Continued from page 247)

when the smallest reading is determined. This, then, should be a true diameter.

The inspection of flat plug gages is similar except that determination of parallelism is substituted for determination of out-of-roundness. See Fig. 16.

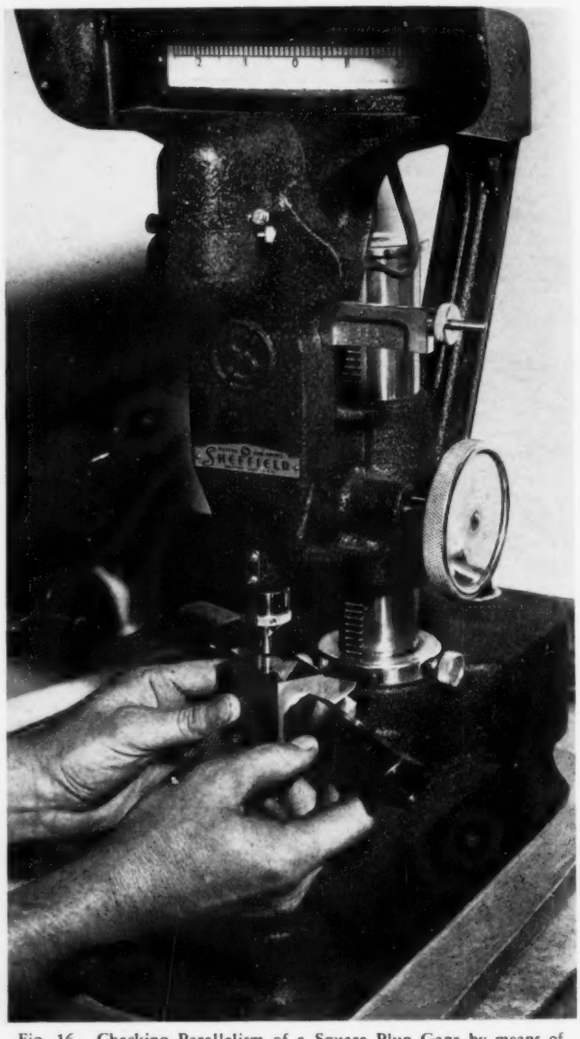

Fig. 16. Checking Parallelism of a Square Plug Gage by means of a Sheffield Comparator. (U. S. Army photograph)

Pin Gages

Pin gages must be inspected more frequently than cylindrical plug gages inasmuch as their point contact will wear more readily than the surface type contact of plug gages. The measurement of pin gages is less complicated than the measurement of plug gages inasmuch as only one diameter in a pin gage can be largest. However, this can be determined only by repeated trial. Again the measuring instrument is selected according to the desired accuracy. The same type of sensitive micrometer used for cylindrical plug gages, being available to the reader who uses both types, will naturally be used by him in measuring his pin gages—though, of course, the extreme accuracy of the sensitive micrometer or measuring machine is really not needed in the inspection of pin gages.

To be Continued

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